Sludge, treated biowaste, and soils in the landscape – Sampling – Part 2: Guidance on sampling techniques

Einführendes Element — Haupt-Element — Ergänzendes Element

Élément introductif — Élément central — Élément complémentaire

ICS:

Descriptors:
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Foreword

This Technical Report (prCEN/TR xxxx-2) has been prepared by Technical Committee CEN BT TF 151 “Horizontal”, the secretariat of which is held by DS.

This document is currently submitted to the CEN Enquiry.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

The following TCs have been involved in the preparation of this document:

CEN/TC 292 Characterization of waste

This Technical Report is one of a series of five, dealing with sampling techniques and procedures, which provide essential information for the application of the EN-standard:

CSS99031: Sludge, treated biowaste, and soils in the landscape - Sampling - Framework for the preparation and application of a sampling plan.

The subject of the Framework Standard is the preparation a sampling plan. The Framework Standard can be used to:

- produce standardized sampling plans for use in regular or routine circumstances;
- incorporate specific sampling requirements into national legislation;
- design and develop a sampling plan on a case by case basis.

The Technical Reports display a range of potential approaches and tools to enable the sampling plan to be tailored to a specific testing scenario. This approach allows flexibility in the selection of the sampling approach, sampling point, method of sampling and equipment used.

This Technical Report describes a range of techniques that could be used to sample sludge and treated biowaste from a variety of locations and soils in the landscape. Information is also provided on the selection and preparation of equipment and apparatus needed to complete the sampling exercise.

This report does not attempt to provide a definitive procedure for each and every situation that could arise for sampling a given material or specific analytical requirement; rather it aims to expose the factors that influence the selection of these practical field activities to ensure the most appropriate procedure is selected for any given sampling scenario.

The most appropriate approach, tools, and methodology should be chosen on a scenario-specific basis. The information presented in this Technical Report should not present a barrier to technical innovation, and there is no reason why other methodologies cannot be substituted, provided they are fit for purpose.
Introduction

Sludge and treated biowaste can be applied to land for the purpose of beneficial land use. The testing of sludge, treated biowaste and soil enables informed decisions to be made on whether land application is appropriate (or not). To undertake valid tests a (number of) representative sample(s) of the sludge, treated biowaste or land will be needed.

The subject of the Framework Standard prEN xxxxx is the preparation of a sampling plan, within the framework of an overall testing programme as illustrated in Figure 1 of prEN xxxxx:date.

The development of a sampling plan within this framework involves the progression through three steps or activities.

1) define the sampling plan;
2) take a field sample in accordance with the sampling plan;
3) transport the laboratory sample to the laboratory

This Technical Report provides information to support Key Step 2 of the sampling plan development and describes a selection of sampling techniques that can be used for a variety of sludges and treated biowastes, and soils in the landscape. The sampling technique is the physical procedure employed to collect part or parts of a material for subsequent investigations. Specifically this Technical Report provides information to support 4.2.9 (Identify the sampling technique) of the Framework Standard.

This Technical Report should be read in conjunction with the Framework Standard for the preparation and application of a sampling plan as well as the other Technical Reports that contain essential information to support the Framework Standard. The full series comprises:

prEN xxxxx: Sludge, treated biowaste, and soils in the landscape – Sampling – Framework for the preparation and application of a sampling plan

prEN ZZZZ:date, Sludge, treated biowaste, and soils in the landscape – Sampling – Vocabulary

prCEN/TR XXXX-1: Sludge, treated biowaste, and soils in the landscape – Sampling – Part 1: Guidance on selection and application of criteria for sampling under various conditions.

prCEN/TR XXXX-2: Sludge, treated biowaste, and soils in the landscape – Sampling – Part 2: Guidance on sampling techniques

prCEN/TR XXXX-3: Sludge, treated biowaste, and soils in the landscape – Sampling – Part 3: Guidance on sub-sampling in the field

prCEN/TR XXXX-4: Sludge, treated biowaste, and soils in the landscape – Sampling – Part 4: Guidance on procedures for sample packaging, storage, preservation, transport and delivery

prCEN/TR XXXX-5: Sludge, treated biowaste, and soils in the landscape – Sampling – Part 5: Guidance on the process of defining the sampling plan for sludge and treated biowaste

The Technical Reports contain procedural options (as detailed in Figure 2 of prEN xxxxx:date) that can be selected to match the sampling requirements of any testing programme.

1 Scope

This Technical Report describes techniques for sampling sludge (liquids, paste-like and particulate materials) and treated biowaste (particulate materials) found in a variety of locations (pipes, lagoons, tanks, trucks, piles, or in bags), and soils in the landscape. The Technical Report provides information to allow
the selection and preparation of equipment and apparatus to be used in the sampling activity as specified in the sampling plan.

NOTE The procedures listed in this Technical Report reflect current best practice, but these are not exhaustive and other procedures might be equally relevant.

2 Normative references

The following documents are indispensable for the application for this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

prEN ZZZZ:date, Sludge, treated biowaste, and soils in the landscape – Sampling – Vocabulary

3 Terms and definitions

For the purposes of this document, the terms and definitions given in prEN ZZZZ and the following apply.

3.1 biowaste
waste that is derived from a biological source material

NOTE Such as food and garden waste, and paper and paperboard (See Annex A.7, Council Directive 1999/31/EC Article 2.m.)

3.2 sludge
mixture of water and solids separated from various types of water as a result of natural or artificial processes

[EN 12832:1999, definition 3.1]

NOTE Attention is drawn to the fact that the term "sludge" is partially defined in the Directives 86/278/EEC and 91/271/EEC.

3.3 viscous liquid
liquid with high viscosity, resulting in slow flow and adhering to containers and sampling equipment


4 Health and safety

Details of the necessary precautions to be taken in sampling operations, including safe working practices for specific locations, the use of protective clothing and equipment, decontamination and emergency procedures should be available. Site-specific health and safety instructions and precautions should be adhered to at all times.

When the circumstances in the field deviate from the situation detailed in the sampling plan it might be necessary to alter the sampling plan for reasons of health and safety. If such changes are needed, the sampling plan might need to be reviewed prior to sampling, for example, if the ability to take representative samples might be compromised.

Detailed guidance on safety during soil sampling is given in ISO 10381-3.

NOTE Attention is drawn to the requirements of (inter)national rules and regulations governing health and safety.
Safety issues will be specific to the site where sampling is carried out. Examples of the type of risk that might be present with respect to sludge and treated biowaste sampling are as follows:

a) treatment plants are often associated with wet flooring which can be covered in minor spillage; presenting a potential for personnel slipping;

b) bacterial and parasitic infection can occur through accidental ingestion or infection via unprotected broken skin and mucous membranes. These risks can be minimized by the adoption of strict personal hygiene codes and the wearing of gloves, goggles, and face masks;

c) sampling from sludge cake stockpiles is not without some risk of personal injury, and care should be taken to avoid the risk of becoming trapped by inducing slippage or sinking. When sampling unconsolidated stockpiles, additional safety instructions might be required;

d) sampling methods will inevitably involve working close to processing plant and moving vehicles. Regard should be given to the requirements for safe working practice when working near moving machinery, for example conveyor belts and press plates or site vehicles;

e) lifting and handling heavy loads can cause personal injury. The maximum mass of a sample to be lifted by an individual is usually specified in (inter)national health and safety legislation;

f) where sludge is sampled using pressure or vacuum systems, care should be taken to prevent exposure of personnel to sludge aerosols formed during the sampling process. Otherwise infectious agents can enter the body via the lungs;

g) sampling in an agricultural area involves an increased risk because the nature of the ground and possible hazards that are not necessarily known.

5 Sampling equipment

Sampling equipment should be appropriate to the type of material being sampled, the sampling location and the size of sample to be collected. Guidance on selection and descriptions of commonly used equipment for sampling sludge and treated biowaste are provided in Annex A. Guidance on selection and descriptions of equipment commonly used for manual sampling of soil is provided in Annex B. Equivalent vehicle-mounted equipment for sampling soil is available.

Prior to use all apparatus and tools should be cleaned to reduce the risk of cross-contamination. If sterilized or disinfected samples are to be collected, sterile sampling equipment should be used.

Where more than one sample is to be collected sampling equipment should be cleaned (and sterilized if necessary) between samples. Where more than one site is to be sampled sampling equipment should be cleaned between sites.

NOTE 1 Due to the nature and composition of the materials being sampled, aseptic techniques are difficult or impractical for sampling purposes. Every effort should be made to ensure cleanliness and good hygiene practices.

NOTE 2 When samples are to be collected from several locations it is advisable to prioritize sampling so that material that has undergone the most treatment is sampled before material that has undergone limited or no treatment.

EXAMPLE Untreated sewage sludge is likely to contain a higher number of micro-organisms than treated sludge. If microbiological parameters are of interest, treated sludge should be sampled before untreated sludge.

6 Selecting a sampling technique

6.1 General

This Technical Report details a range of sampling techniques that can be used to take a sample. The procedures identified in this document target two fundamental objectives of sampling:
CSS99057:2007 Guidance on sampling techniques

--- probabilistic sampling – the preferred method of sampling or recovering material where a quantifiable level of reliability is required in the results for the population being tested. The basis for probabilistic sampling is that each element within the population being sampled has an equal chance of being sampled. This means that the whole population can be accessed and a sample can be collected that is representative of that population;

--- judgemental sampling – this is used where representative sampling from the whole population is impractical, or when sampling is required to target a specific item or point within the population.

The preferred sampling technique will depend on a combination of the characteristics of the material and the sampling location. Relevant factors include:

--- the type of material / the physical state of the material (e.g. liquid, paste, sludge, granules);

--- the situation at the sampling location / the way in which the material occurs (e.g. in a tank, a stockpile, in a bag);

--- the (expected) degree of heterogeneity (e.g. homogeneous liquids, layered liquids, segregated sludges);

6.2 Decision flow chart for the selection of sampling techniques

Clauses 7-10 describe sampling procedures for a range of materials and storage conditions. A decision flow chart (Figure 1) directs the reader to the relevant clauses in the document. The procedures described in this Technical Report reflect current best practice, but these are not exhaustive and other procedures might be suitable if they can be demonstrated to produce representative samples.

This Technical Report has been structured to address the selection of sampling techniques and equipment by physical form (e.g. liquid, sludge or granules) and the way in which the material occurs (e.g. road tanker, stockpile or bag). This Technical Report does not present a definitive process, but reflects current practice for commonly occurring scenarios, but this does not mean that other solutions are not available. The selection of an appropriate sampling technique should be related to the objectives for sampling, the physical form and the physical, chemical or microbiological characteristic to be measured.

6.3 Preparing the laboratory sample

Some sampling methods will result in more than one increment, which might require further preparation such as combining and/or sub-sampling, as specified in the sampling plan.

If the increments are to be examined individually, label the increments as specified in the sampling plan.

If the samples are to be examined combined, mix the increments in the proportions specified in the sampling plan and sub-sample if necessary to give a representative sample and label as specified in the sampling plan.
Figure 1 — Decision flow chart for selecting sampling techniques
7 Sampling liquid sludge

7.1 General

Often liquid sludges can be readily taken from taps or valves situated on outlet pipework. In other circumstances, it might be necessary to take dipped samples from a road tanker, storage tank or lagoon. Practical and safety considerations might dictate the point at which samples can be obtained.

Where sludges are likely to have settled and stratified the performance of tanks cannot always be gauged from samples taken from inlet and outlet pipelines. The segregation of solids that is likely to occur can be detected by sampling different sections and depths.

7.2 Sampling from tanks or road tankers

7.2.1 Probabilistic sampling

7.2.1.1 Preparation for sampling

Sludge in tanks or road tankers can be regarded as homogeneous if the whole volume is thoroughly mixed before sampling.

NOTE 1 Sludges that are left to settle tend to stratify into layers and should not be regarded as homogeneous.

NOTE 2 On-site homogenization (e.g. circulation) minimizes the need for sampling stratified material.

If the sludge is known to be homogeneous, sample using the procedure described in 7.2.1.2 (Procedure for taking a probabilistic sample where contents are known to be mixed or are homogenous).

Unless the sludge is known to be homogeneous, assume the sludge is heterogeneous. Either sample using the procedure described in 7.2.1.3 (Procedure for taking probabilistic samples where contents are not mixed or are heterogeneous) or determine the stratification and sample using the procedure described in 7.2.1.4 (Procedure for taking a probabilistic sample from heterogeneous (stratified) liquids).

7.2.1.2 Procedure for taking a probabilistic sample where contents are known to be mixed or are homogenous

If the tank is being emptied, samples can be collected as described in 7.3 (Sampling liquid sludge from a pipeline). If the tank is not being emptied, use a sampling tube to sample the full depth of the liquid and proceed as follows:

- Lower the open sampling tube into the tank sufficiently slowly to ensure that the liquid level in the tube does not fall below that of the outside liquid;
- Close the tube, withdraw it from the tank then allow any liquid adhering to it to drain from it or wipe the tube dry;
- Transfer the contents of the sampling tube to the sample container;
- Repeat the procedure until sufficient quantity of sample is collected.

Pumping action should not be used to increase the size of the sample taken in any one procedure.

7.2.1.3 Procedure for taking probabilistic samples where contents are not mixed or are heterogeneous

If the tank is being emptied samples can be collected as described in 7.3 (Sampling liquid sludge from a pipeline). Otherwise proceed as follows.
Access to different strata is often provided by a design feature such as stepped draw-off pipework. Inspection of the tank concerned will usually reveal the presence of these facilities if they have been built in. When this is not the case, vacuum sampling devices could be used (see A.3.2a).

Alternatively, take increments at depth intervals using a sampling tube or a weighted sampling device as described in 7.2.2.3 (Procedure for taking a sample at specified depth).

Start sampling from the top layer and take samples at equally spaced intervals, as specified in the sampling plan.

7.2.1.4 Procedure for taking a probabilistic sample from heterogeneous (stratified) liquids

Establish the volume per layer to allow calculation at a later stage of the average concentrations within the tank.

Method 1: Using a transparent sampling tube

— Take a sample of the entire depth;
— Lower the open sampling tube into the tank sufficiently slowly to ensure that the liquid level in the tube does not fall below that of the outside liquid;
— Close the tube, withdraw it from the tank then allow any liquid adhering to it to drain from it or wipe the tube dry;
— If layering is observed, calculate the volume per layer in the tank as follows: measure the depth of each layer identified in the sampling tube and estimate the mean cross-sectional area of the tank over that depth. For each layer, multiply the cross-sectional area by the depth of the layer;
— Record the information in the sampling record (see 12).

Method 2: Mixed surface and bottom sample

— A surface and bottom sample are mixed in equal volumes then allowed to stand so that any layering can be observed;
— Take a single surface sample as described in 7.2.2.1 (Procedure for taking a surface sample) and transfer the sample to a transparent bottle;
— Take a single bottom sample as described in 7.2.2.2 (Procedure for taking a bottom sample) and transfer the sample to the bottle with the surface sample;
— Cap the bottle and invert to mix the samples, then allow to stand for a minimum of 2 minutes;
— If layering is observed, calculate the volume per layer in tank as follows: measure the depth of each layer identified in the sampling tube and estimate the mean cross-sectional area of the tank over that depth. For each layer, multiply the cross-sectional area by the depth of the layer;
— Record the information in the sampling record (see 12).

If layering is not observed, sample using the procedure described in 7.2.1.3 (Procedure for taking probabilistic samples where contents are not mixed or are heterogeneous).

If layering is observed, the liquid is stratified. Collect a separate sample from the centre of each layer using the procedure described in 7.2.1.3 (Procedure for taking probabilistic samples where contents are not mixed or are heterogeneous).
Alternatively, if the tank is being emptied samples can be collected as described in 7.3 (Sampling liquid sludge from a pipeline).

7.2.2 Judgemental sampling

7.2.2.1 Procedure for taking a surface sample from a tank

Surface samples should be collected using a bailer or weighted can, as follows:

- Lower a bailer or weighted can into the tank to just below the surface of the liquid;
- Remove the bailer/can before it fills completely;
- Transfer the contents of the can to the sample container, using a funnel if necessary;
- Repeat the procedure until sufficient quantity of sample is obtained.

7.2.2.2 Procedure for taking a bottom sample from a tank

Samples should be collected from the bottom of a tank using a sampling tube, as follows:

- Insert a closed sampling tube into the liquid until it touches the bottom of the tank;

NOTE The viscosity of the liquid can affect the choice of the sampling tube (see sampling plan).

- Open the sampling tube and move quickly allowing the mouth of the tube to traverse the bottom of the tank while the tube is filling;
- Close the tube, withdraw it from the tank then allow any liquid adhering to it to drain from it or wipe the tube dry;
- Transfer the contents of the sampling tube to the sample container.

7.2.2.3 Procedure for taking a sample at specified depth

Take a sample using a sampling tube (Method 1) or a weighted sampling device (Method 2).

NOTE Suitable weighted sampling apparatus is described in Annex A.

Method 1: Using a sampling tube

- Insert a closed sampling tube to the depth specified in the sampling plan;
- Open the sampling tube and allow the tube to fill;
- Close the tube, withdraw it from the tank then allow any liquid adhering to it to drain from it or wipe the tube dry;
- Transfer the contents of the sampling tube to the sample container;

Method 2: Using a weighted sampling device

- Ensure that a chain is attached to the stopper;
- Close the bottle or can by inserting the stopper and lower the apparatus to the depth specified in the sampling plan;
--- Open the bottle or can by pulling sharply on the chain to remove the stopper;
--- When air bubbles cease to rise, lift the apparatus out of the liquid;
--- Carefully pour off the liquid contained in the neck of the bottle or can;
--- Either transfer the remaining liquid into the sample container or, if the collection vessel is to be used as the sample container, tightly close the collection vessel and remove it from any supporting cage apparatus.

### 7.3 Sampling liquid sludge from a pipeline

#### 7.3.1 Preparation for sampling

Samples can be collected from the end of a pipeline if the flows from the pipeline under gravitational pressure or if the liquid is being pumped.

Factors such as the nature of the sludge, the flow rate, the diameter of the pipes and the roughness of the pipe can affect the tendency of the dynamic system to allow streaming of the flow. The influence of this potential problem can be minimized by allowing the flow to equilibrate before collecting a sample.

Check the flow rate before and during sampling. When taking the sample, visual checks should be made to ensure that the flow rate and consistency do not vary noticeably.

**NOTE** Blockages in pipes due to fibrous materials will often influence the nature of the sludge by a filtering action. If this is detected at the time of sampling, repeat the sampling after the blockage has been cleared.

Clean all sampling ports prior to sampling. If sampling from a tap or valve allow a small volume to be discharged before sampling to ensure that any stagnant material in the tap or valve is removed. Any side arms or valves utilized in the sampling arrangement should be flushed with at least three times the standing volume to ensure that any stagnant material is removed from the pipework.

#### 7.3.2 Taking a probabilistic sample from the end of a pipeline

Samples should be taken at appropriate intervals at the pump outlet or a similar convenient place, as follows:

--- Use a funnel to channel the liquid into the sample container. To collect a representative sample put the sample container, with funnel, under the exit stream at regular intervals during the whole of the transfer of the liquid as specified in the sampling plan.

**NOTE** For road tankers, a long-handled ladle can be used to take samples at intervals from the exit stream.

#### 7.3.3 Taking a judgemental sample from the end of a pipeline

A sample should be taken at the pump outlet or a similar convenient place, as follows:

--- Use a funnel to channel the liquid into the sample container. Place the sample container, with funnel, under the exit stream for the period specified in the sampling plan.

**NOTE** For road tankers, a long-handled ladle can be used to take a sample from the exit stream.

### 7.4 Sampling from a lagoon

#### 7.4.1 Taking a sample when the lagoon is being emptied by pumping

Follow the procedure for sampling liquid sludge from a pipeline (7.3).
7.4.2 Sampling from around the perimeter of the lagoon

7.4.2.1 General

When access to the whole lagoon is not possible, take samples around the perimeter of the lagoon. Since samples are not collected from the whole volume, sampling is judgemental.

7.4.2.2 Taking a perimeter sample using a weighted bottle

- Lower the weighted bottle sampling device or sampling can to the depth specified in the sampling plan using the connecting cord or rope to gauge the depth of sampling.
- Give a sharp jerk on the cord connected to the bottle stopper and allow sufficient time for the sampling device to fill.
- Withdraw the sampling device and remove the bottle.
- Refit the stopper eliminating any air from the neck of the bottle.

7.4.2.3 Taking a perimeter sample using a pond sampling device

- Insert the pond sampling device, with a clamped beaker, upside-down into the lagoon;
- Invert the pond sampling device at the specified location and depth;
- Withdraw the sampling device and transfer the sample to the transparent sample bottle, eliminating any air from the neck of the bottle.

8 Sampling sludge cake

8.1 General

For caked sludge, storage over a period of time might form part of the treatment process. Sludge cake is typically stored in the open and, as a consequence, there are likely to be differences between the top layer and the bulk material (e.g. exposure to the elements or cross-contamination by wind-blown material or animal droppings). Similarly, samples taken from the base of a heap or stockpile might include grit or sand from the bed media. If the differences are relevant to the outcome of the sampling then the top layer and base layer should be seen as a different material.

Major variations can be found throughout stockpiles, particularly old ones. When sampling sludge cake from stockpiles it is important to obtain portions of sludge from throughout the mass and not just from the surface layer. Safety requirements might prohibit routine sampling in this manner. In this case, assessing the cross-sections of a heap with a mechanical excavator should be considered if it can be safely undertaken to enable representative sampling.

Depending on the treatment process, lime-treated sludge samples can be similar in texture to caked sludge, in which case sample as for caked sludge. In other cases lime-treated sludge might be extruded as a paste. In this case sample as for paste-like sludges (see 9).

8.2 Preparation for sampling

8.2.1 General

Note and record the thickness and nature of any surface crust. Carefully remove the full depth of the surface crust to a thickness of not less than 100 mm and discard.
NOTE Over time the top layers of the sludge desiccate to form crusts which allow anaerobic activity to increase in lower layers and aerobic activity to increase in the upper near-surface layers. Chemical species might migrate due to leaching in these situations. In this case the surface layers are not representative of the rest of the sludge cake.

8.2.2 Probabilistic sampling

8.2.2.1 Taking a sample through the depth of a heap or stockpile

If after assessment of safety requirements and the availability of equipment, core sampling can be considered as a means of obtaining samples, samples should be taken from the depth of the heap/stockpile.

Use a pile sampling device (see A.3.8) if the heap or stockpile has a cross-sectional diameter of 1 m or more.

Insert the pile sampling device into the material being sampled at an angle between 0 to 45° from horizontal.

Rotate the pile sampling device two or three times in order to cut a core of the sludge cake.

Slowly withdraw the pile sampling device, making sure that the slot is facing upward.

Transfer the sample into the sample container with the aid of a spatula.

Repeat the sampling at different sampling points as specified in the sampling plan.

8.2.2.2 Taking a sample from cross-sections of a heap or stockpile

Remove and discard the surface crust to a thickness of not less than 100 mm.

Take a sample from the cleaned surface using a trier or an auger.

Rotate the sampling implement two or three times in order to cut a core of the sludge cake.

Slowly withdraw the sampling implement.

Transfer the sample into the sample container with the aid of a spatula.

Repeat the sampling at different sampling points along the width or circumference of the stored material as specified in the sampling plan.

8.2.3 Judgemental sampling

Collect individual samples from the part of the stockpile specified in the sampling plan following the procedure in 8.2.2.1 or 8.2.2.2.

9 Sampling extruded paste-like sludges

9.1 General

This procedure is suitable for sludges that are extruded under pressure, for example some lime-treated sludges.

NOTE For lime-treated sludges, the treatment specification might dictate that sampling or batch release approval should not occur until after the sludge has cooled to below a specified temperature. In this case, sampling should not take place until the temperature has been measured and confirmed to be below the specified temperature.
Typically, the sludge is extruded onto a heap as bars of various lengths. For the purposes of sampling, the sludge can be regarded as a heap or as a number of separate bars.

If the sampling plan specifies that samples are to be taken through the depth of the heap or from a cross-section of the heap, follow the procedures for sampling sludge cake (see 8) otherwise follow the procedures in 9.2.

9.2 Taking samples from extruded bars

— Identify the bars to be sampled as specified in the sampling plan.

NOTE It is unlikely that the extruder can be stopped prior to sampling. It is advised that the selected bars are removed to a safe place for sampling.

— Take a sample from the bar by taking a cross-section (method 1) or using a scoop (method 2).

Method 1: Taking cross-section

— Cut out a piece of the extruded bar of length specified in the sampling plan by cutting at right angles through the bar at two places with a knife or cutting wire.

— Remove the sample from between the two cuts and transfer to the sample container.

Method 2: Using a scoop

— Scoop out the required amount of material as identified in the sampling plan.

— Transfer the sample to the sample container.

10 Sampling particulate materials

10.1 General

Materials that can be regarded as granular include thermally treated sludges (dried granules and pellets) or treated biowaste (composted materials).

Whenever possible, sampling from the bulk material should be carried out from a moving stream of material, the whole product being sampled.

Thermal drying processes generally produce a product that is of a pellet or granular character and is often bagged or packaged for transport in quantities of 1 tonne. Often it is possible to sample directly into a sample container from an in-line hopper or hatch in the pipework leading to the bagging silo. In this case follow the procedure for sampling from a falling stream (10.4). Otherwise follow the procedure for sampling from large bags (10.3).

All sampling operations should be carried out over a sufficiently short period of time and in such a way as to avoid any alteration in the characteristics of the product delivered or the samples.

It is essential that the sampling system be designed to avoid the following:

— Spillage of the sample;

— Restriction of the bulk material through the system;

— Retention of residual material;

— Contamination of the sample;
Change in moisture content.

NOTE 1 Thermally dried sludges generally possess very low water contents and sampling and storage procedures should take this into account in order that the product does not change significantly after treatment.

NOTE 2 Some sampling implements can cause degradation of the material and care should be taken to ensure that the properties of the material deemed critical to the laboratory measurements are not affected by the sampling implement.

NOTE 3 Microbiological cross-contamination of samples has been reported when sampling thermally treated sludges from in-line hoppers.

NOTE 4 Normal handheld shovels should not be used since, unlike sampling scoops, they do not have sides. When a shovel is used sample constancy cannot be guaranteed since sampled material will fall off the shovel after sampling and larger particles will tend to roll off the heap that is formed on a shovel.

10.2 Sampling from heaps and stockpiles

10.2.1 General

Probabilistic sampling can be easier to accomplish when material is being transferred to a stockpile or heap, but this is often not possible, therefore sampling has to be carried out from the static stockpile or heap.

If the material in the stockpile is loose, it might be difficult or even impossible, for reasons of safety, to reach the selected sampling locations for manual sampling. If so, the type of sampling equipment should be adapted to this type of sampling situation or alternative access equipment could be employed, e.g. cherry picker access platforms.

10.2.2 Preparation for sampling

The choice of sampling equipment will be determined by the size of the heap or stockpile and the flow characteristics and dryness of the material to be sampled. Small and large static volumes can be differentiated by taking into account the ease with which the whole volume can be accessed. Volumes up to about 3 m depth might be considered small.

The aperture of the sampling equipment should be significantly larger than (at least three times as large) the nominal top size of the material being sampled to ensure a representative sample is taken.

10.2.3 Probabilistic sampling

Method 1: Sampling small static volumes

— Push a core sampling device through the material at the appointed sampling point and in the identified direction as specified in the sampling plan so that the full cross-section is traversed.

— Transfer the sample into the sample container.

Method 2: Sampling large static volumes

— Push a vacuum probe or sampling tube through the material at the appointed sampling point and in the identified direction taking a series of individual samples until the traverse is complete as specified in the sampling plan.

— Transfer the directional sample into the sample container.

Method 3: Sampling large static volumes by partial excavation
NOTE To take samples at greater depths, or when the material is unconsolidated, it might be possible to partially excavate a large stockpile. This requires sufficient space for the storage of the excavated material and availability of a suitable excavating machine. The integrity of the sample at the locations defined in the sampling plan should be preserved.

- Partially excavate the stockpile using an excavating machine, transferring the excavated material to a suitable clean location.
- Take additional samples from the remainder of the stockpile following the procedure in method 2.

10.2.4 Judgemental sampling

Preference should be given to probabilistic sampling; however in cases where it is not possible to access all the material in a heap or stockpile, judgemental sampling is necessary. Heaps and stockpiles are typically stored in the open and, as a consequence, there are likely to be differences between the top layer and the bulk material (e.g. exposure to the elements or cross-contamination by wind-blown material or animal droppings). If the differences are relevant to the outcome of the sampling then the top layer should be seen as a different material. Similarly, samples taken from the base of the heap or stockpile might include grit or sand from the bed media.

- Push a scoop into the material at the area identified in the sampling plan.
- Withdraw the scoop and level off the material so there is none above the sides of the scoop.
- Transfer the sample into a sample container.

10.3 Sampling from large bags

10.3.1 Probabilistic sampling

Method 1: Taking a sample through the depth of the bag

- Ignoring material nearer than 50 mm to any surface, push a vacuum probe, core sampling device or sampling tube through the material in the direction identified in the sampling plan.
- Transfer the directional sample into a sample container.

Method 2: Taking samples when emptying the bag

- Ignoring material nearer than 50 mm to any surface, remove the material from the bag in layers to the depths specified in the sampling plan.
- At each depth, take a scoop of material and level off the material so there is none above the sides of the scoop.

10.3.2 Judgemental sampling

- Ignoring material nearer than 50 mm to any surface, push a scoop into the material at the area identified in the sampling plan.
- Withdraw the scoop and level off the material so there is none above the sides of the scoop.
- Transfer the sample into a sample container.
10.4 Sampling from a falling stream

10.4.1 Preparation for sampling

The techniques given in 10.4.2 and 10.4.3 apply only to manual sampling; automatic sampling might be more appropriate where the demand is high.

Take samples from as close to the point of exit as possible.

10.4.2 Probabilistic sampling

10.4.2.1 Taking a cross-sectional sample with a scoop or sample container

The aperture of the sampling equipment should be significantly larger than (at least three times as large) the nominal top size of the material being sampled to ensure a representative sample is taken.

Falling streams differ in width and depth and can be differentiated by the ease with which the full cross-section of the stream can be accessed. This depends on the size of the sampling equipment. For falling streams with small depth and width, the cross-sectional area of the stream should be less than the cross-sectional area of the scoop used for sampling.

The sampling action should collect a complete cross-section of the stream; both the leading and trailing edges should clear the stream in the same path.

Method 1: where width and depth of stream is small

- Put a scoop into the stream, at 90 degrees to the falling stream, using a single one directional action.
- Hold the scoop in place for the period specified in the sampling plan.
- Remove the scoop in the direction of entry.
- Transfer the sample into a sample container.

Method 2: where width of stream is large and depth is small

- Insert a container at one end of the stream and, at a uniform rate designed to collect the required amount of material, move the container through the width of the stream to the opposite end.

Method 3: where width and depth of stream is large

- Take a first sample following the procedure in method 1.
- Repeat the procedure, taking a second sample at 90 degrees to the first direction of sampling.
- Transfer both samples to the sample container.

10.4.2.2 Taking a cross-sectional sample with a receptacle with aperture

The aperture of the receptacle should be larger than the full width of the stream and significantly larger than (at least three times as large) the nominal top size of the material being sampled to ensure a representative sample is taken.

- Place the closed receptacle under the falling stream.
- Open the aperture and collect the amount of material as specified in the sample plan.
Close the aperture and remove the receptacle from the falling stream.

Transfer the sample to a sample container.

### 10.4.3 Judgemental sampling

The aperture of the container should be significantly larger than (at least three times as large) the nominal top size of the bulk material being sampled to ensure a representative sample is taken.

Put a sample container into the stream to the location identified in the sampling plan using a single one directional action.

**NOTE** The placement of the sampling container should be in the same axis as the falling stream or at 90 degrees to the falling stream. Hold the sample container in place for the period as specified in the sampling plan.

Remove the container in the direction of entry.

### 11 Sampling soils in the landscape

For all topsoil sampling it is important that the whole of the sampling depth is equally represented by each replicate core. Therefore if, on retrieval, part of the core is missing, i.e. the bottom part is left in the ground (this often happens in dry or stony soils) or the top part falls off (because it is dry), discard this core and take a replacement close by. If it proves impossible to retrieve a complete core, either delay sampling until the soil is less dry or use alternative equipment that is better suited to the sampling situation.

The top few centimetres of soil should be included. There is often a different pH and/or concentration of soil nutrients (particularly phosphorus) at the surface in grass land and direct drilled/shallow cultivated fields. It is therefore essential that the top few centimetres are included in the sample.

Take care when taking soil samples. It is difficult to remove certain soils from some sampling equipment, e.g. some push sampling devices. If removal of the soil sample is difficult, use alternative sampling equipment if possible.

Several incremental samples might be combined to produce a composite sample that better represents the population that was sampled. To form a composite sample per area unit, sampling procedures should be selected so that the final sample contains equal parts of the incremental samples, and to ensure that it is representative of all the incremental samples.

Composite samples representative of the media do not require intact undisturbed samples to be collected.

After sampling, large holes should be backfilled with surrounding soil to avoid any risk to animals or humans.

### 12 Incorporation in the sampling plan

The selected sampling technique(s) and equipment should be specified in the sampling plan prior to commencing sampling.

### 13 Sampling record

Any observations made during sampling should be documented in the sampling record, e.g. the depth of the layers in stratified liquids; the thickness and nature of any surface crust.
Annex A
(informative)
Support on the selection of equipment

A.1 General

In general, sampling equipment is most practical if it is as simple in design and construction as possible. Tools should be chosen to suit the sampling activity. For some materials and sampling situations, e.g. liquid sludge sampled from a pipeline, permanent equipment might be installed for sampling at fixed points.

The size of the sampling tool will vary according to the quantity of sample needed, the physical properties of the material to be sampled, and the type of sample to be collected (e.g. disturbed or undisturbed). A critical factor might be that it should be possible to traverse the entire depth of the material that is to be sampled in a single action of the sampling device. It should be possible to extract an unbiased sample using the selected sampling device. The optimum device should yield a sample where it is easy to see if parts of it are missing and where sample depth can be determined.

For granular samples (e.g. pelletized sludge or composted biowaste) the aperture size of the sampling tool should be significantly larger than (at least three times as large) the maximum particle size to ensure a representative sample is taken.

NOTE For soil samples, the choice of sampling device will depend on the depth of the desired sample, the type of sample required (disturbed or undisturbed) and the soil type.

All sampling equipment should preserve those characteristics of the material that are to be measured. The equipment should be assessed for potential for interference on test results.

Sampling apparatus and tools should be kept clean. Rusty tools or those with chipped or flaking surface coatings and painted surfaces should not be used if they might contaminate the samples. Any form of corrosion should be removed prior to sampling. For soils, this might be achieved by first drilling a test hole in the sampling area and discarding the sampled material. Equipment to be used to collect samples for microbiological analysis should be suitable for sterilization, if necessary.

Published research on the examination of gouges made from non-toxic iron-manganese steel and chromium-nickel steel and their ability to contaminate samples during normal use has demonstrated that the sampling devices did not increase the metal content of the samples. However, caution should be taken when using some metal sampling devices when metals are to be measured in the samples:

EXAMPLE 1 The use of aluminium extension pipes to a sampling valve would be inappropriate if the samples were being taken for the analysis of an aluminium flocculation assister.

EXAMPLE 2 High alloy steels should be avoided if trace metals are to be determined.

EXAMPLE 3 The use of stainless steel tools is routinely adopted, but can be a source of contamination if analyses for elements such as chromium are to be performed.

A.2 Equipment selection

Factors to be considered when choosing sampling equipment are:

— suitability for purpose;
— safety in operation;
— ability to take a representative sample;
Information should be sought on:

a) The characteristics of the material to be sampled:
   - the solids content / moisture content;
   - the consistency;
   - the physical structure;
   - particle size distribution (e.g. stone and clay content of soils).

b) Accessibility and safety:
   - the sampling site;
   - where and how the material is being stored (e.g. heap, bag, lagoon);
   - the accessibility of sampling points;
   - the hazard assessment of the sampling activities;
   - the safety procedures to be implemented during sampling.

c) The size and purpose of the sample:
   - the final quantity of sample required;
   - how the sample will be analysed (i.e. physical, chemical or microbiological analyses);
   - any special analytical considerations (e.g. volatile organic compounds (VOC)).

Suggested applications for generic types of sampling equipment are listed in Table A.1. Detailed descriptions of the equipment are presented in Figures A1-A19 and accompanying text (A.3).
Table A.1 – Suggested applications for generic types of sampling equipment

<table>
<thead>
<tr>
<th>Sampling tool</th>
<th>Main application</th>
<th>Application</th>
<th>Aperture (mm)</th>
<th>Sample length (cm)</th>
<th>Maximum sampling depth (m)</th>
<th>Level of disturbance</th>
<th>Fit for stratified sampling</th>
<th>Can be sterilized</th>
<th>Fit for analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Augers (general sampling, non-volatile)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dutch or Edelman Auger</td>
<td>Universal sampling device for dry or stony soil-like materials</td>
<td>+++</td>
<td>+++</td>
<td>-</td>
<td>++</td>
<td>-</td>
<td>40-200</td>
<td>10-15</td>
<td>5-10</td>
</tr>
<tr>
<td>Bucket auger</td>
<td>Universal sampling device for dry or stony soil-like materials</td>
<td>+++</td>
<td>+++</td>
<td>-</td>
<td>++</td>
<td>-</td>
<td>40-200</td>
<td>10-15</td>
<td>3</td>
</tr>
<tr>
<td>Riverside auger</td>
<td>Universal sampling device for dry or stony soil-like materials</td>
<td>+++</td>
<td>+++</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>40-200</td>
<td>10-15</td>
<td>5-10</td>
</tr>
<tr>
<td>Stony soil auger</td>
<td>Universal sampling device for dry or very stony soil-like materials</td>
<td>+++</td>
<td>+++</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>60-200</td>
<td>10-15</td>
<td>5-10</td>
</tr>
<tr>
<td>Spiral or screw auger – hand operated</td>
<td>Loosening stones in boreholes</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>5-50</td>
<td>&lt;200</td>
<td>&lt; (1)</td>
</tr>
<tr>
<td>Spiral or flighted auger – drill rig-operated</td>
<td>Drilling; some sampling in soft soils</td>
<td>++ (2)</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>5-50</td>
<td>100-200</td>
<td>&gt;10</td>
</tr>
</tbody>
</table>

Gouges (general environmental sampling in hard soil-like material)
### Guidance on Sampling Techniques

<table>
<thead>
<tr>
<th>Sampling tool</th>
<th>Main application</th>
<th>Application</th>
<th>Aperture (mm)</th>
<th>Sample length (cm)</th>
<th>Maximum sampling depth (m)</th>
<th>Level of disturbance</th>
<th>Fit for stratified sampling</th>
<th>Can be sterilized</th>
<th>Fit for analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gouge operated with body weight</td>
<td>Soft &amp; cohesive soil-like materials</td>
<td>+++</td>
<td>+ to 6 cm</td>
<td>10-60</td>
<td>30-100</td>
<td>0.5-10</td>
<td>+++</td>
<td>yes</td>
<td>tm +++ vol -</td>
</tr>
<tr>
<td>Handhammer operated gouge</td>
<td>Cohesive &amp; hard soil-like materials</td>
<td>+++</td>
<td>-</td>
<td>25</td>
<td>30-100</td>
<td>0.5-10</td>
<td>+++</td>
<td>yes</td>
<td>tm +++ vol -</td>
</tr>
<tr>
<td>Percussion operated gouge (window sampling device)</td>
<td>Soil-like materials with debris</td>
<td>+++</td>
<td>-</td>
<td>40-100</td>
<td>50-200</td>
<td>&lt;10</td>
<td>+++</td>
<td>yes</td>
<td>tm +++ vol +</td>
</tr>
<tr>
<td>Peat sampling device</td>
<td>Sediments / sludges</td>
<td>-</td>
<td>-</td>
<td>25</td>
<td>50</td>
<td>&lt;10</td>
<td>++</td>
<td>+++</td>
<td>yes</td>
</tr>
<tr>
<td>Flap gouge auger (small peat sampling device)</td>
<td>Powders / sediments / sludges / bio-reactors</td>
<td>-</td>
<td>-</td>
<td>12</td>
<td>25</td>
<td>&lt;3</td>
<td>++</td>
<td>+++</td>
<td>yes</td>
</tr>
<tr>
<td>Core sampling devices (environmental sampling of soil-like material and sediments)</td>
<td>Soil-like materials to be analysed for volatiles</td>
<td>+++</td>
<td>-</td>
<td>15-40</td>
<td>5-20</td>
<td>&lt;10</td>
<td>+++</td>
<td>yes</td>
<td>tm +++ vol +++</td>
</tr>
<tr>
<td>Profile sampling devices with sharp cutting edges</td>
<td>Soil-like materials with fibres or roots</td>
<td>++</td>
<td>+</td>
<td>5-15</td>
<td>40-200</td>
<td>&lt;200</td>
<td>+++</td>
<td>yes</td>
<td>tm (3) vol +</td>
</tr>
<tr>
<td>Grass root sampling device</td>
<td>Top soil for air-borne deposits (e.g. caesium)</td>
<td>+</td>
<td>-</td>
<td>2-3</td>
<td>5-10</td>
<td>5-10</td>
<td>++</td>
<td>--</td>
<td>yes</td>
</tr>
<tr>
<td>Core sampling devices with piston (environmental sampling on submerged sediments, water-saturated biowaste, pasty sludge)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Sampling tool</td>
<td>Main application</td>
<td>Application</td>
<td>Aperture (mm)</td>
<td>Sample length (cm)</td>
<td>Maximum sampling depth (m)</td>
<td>Level of disturbance</td>
<td>Fit for stratified sampling</td>
<td>Can be sterilized</td>
<td>Fit for analysis</td>
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<td>---------------</td>
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</tr>
<tr>
<td>Piston sampling devices</td>
<td>Liquid-saturated uncohesive materials</td>
<td>- - + -</td>
<td>30-50</td>
<td>75-200</td>
<td>&lt;10</td>
<td>+++</td>
<td>+++</td>
<td>difficult</td>
<td>tm +++ vol +</td>
</tr>
<tr>
<td>Piston sampling devices with lockable cutting head</td>
<td>Liquid-saturated uncohesive harder materials</td>
<td>- - + -</td>
<td>60-70</td>
<td>50-150</td>
<td>&lt;10</td>
<td>+++</td>
<td>+++</td>
<td>difficult</td>
<td>tm +++ vol +</td>
</tr>
<tr>
<td>Remote operated piston sampling devices</td>
<td>Liquid-saturated uncohesive materials at larger depths</td>
<td>- - 0 -</td>
<td>50-70</td>
<td>500</td>
<td>&gt;5</td>
<td>+++</td>
<td>+++</td>
<td>no</td>
<td>tm +++ vol +</td>
</tr>
<tr>
<td>Spoons; Spades; Scoops</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<td></td>
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<tr>
<td>Spoon</td>
<td>Fine dry or moist bulk material</td>
<td>+ 0 - + 30</td>
<td>- 0 0 -</td>
<td>yes</td>
<td>tm +++ vol -</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spade (flat)</td>
<td>Dry or moist bulk material; soil</td>
<td>++ ++ - ++ ++</td>
<td>200 20 &lt;2 +</td>
<td>yes</td>
<td>tm +++ vol +</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Spade with sides</td>
<td>Waste with debris</td>
<td>- ++ - ++ ++</td>
<td>150-300 20 &lt;1 +</td>
<td>yes</td>
<td>tm +++ vol +</td>
<td></td>
<td></td>
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<tr>
<td>Scoop/trowel</td>
<td>+ + - + (4)</td>
<td>15 &lt;0.5 0 -</td>
<td>yes</td>
<td>tm ++ vol -</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bailers</td>
<td></td>
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<tr>
<td>Weighted bottle/Weighted cage with sample bottle</td>
<td>Liquids and free-flowing slurries</td>
<td>- - +++ (5)</td>
<td>500 ml 15</td>
<td>- -</td>
<td>yes</td>
<td>tm ++ vol +</td>
<td></td>
<td></td>
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<thead>
<tr>
<th>Sampling tool</th>
<th>Main application</th>
<th>Application</th>
<th>S</th>
<th>C</th>
<th>L</th>
<th>SC/P</th>
<th>P</th>
<th>Aperture (mm)</th>
<th>Sample length (cm)</th>
<th>Maximum sampling depth (m)</th>
<th>Level of disturbance</th>
<th>Fit for stratified sampling</th>
<th>Can be sterilized</th>
<th>Fit for analysis</th>
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<td>Simple weighted can</td>
<td>Liquids</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+++</td>
<td>-</td>
<td>-</td>
<td>500 ml</td>
<td>15</td>
<td>-</td>
<td>-</td>
<td>yes</td>
<td>tm ++</td>
<td>vol +</td>
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<tr>
<td>Valve sampling cylinder (sinker sampling device)</td>
<td>Liquids</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+++</td>
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<td>++</td>
<td>yes</td>
<td>tm ++</td>
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<tr>
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<td>+++</td>
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<td>500 ml</td>
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<td>tm ++</td>
<td>vol +</td>
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<td>-</td>
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<td>-</td>
<td>+++</td>
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<td>+++</td>
<td>+++</td>
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<td>tm ++</td>
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<tr>
<td>Drum and tank sampling device</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>+++</td>
<td>-</td>
<td>-</td>
<td>1</td>
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<td></td>
<td>+++</td>
<td>+++</td>
<td>yes</td>
<td>tm ++</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>+++</td>
<td>-</td>
<td>-</td>
<td>20-40</td>
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<td>1.5</td>
<td>+++</td>
<td>+++</td>
<td>yes</td>
<td>tm +++</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>(volume 150-600 ml)</td>
<td>2.5-4.5</td>
<td>-</td>
<td>-</td>
<td>yes</td>
<td>tm ++</td>
<td>vol +</td>
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<td><strong>Pumps</strong></td>
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<tr>
<td>Vacuum pumps</td>
<td>Liquids and free flowing particulates</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+++</td>
<td>-</td>
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<td>-</td>
<td>-</td>
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<td>tm ++</td>
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<td>Peristaltic pump</td>
<td>Liquids, sludges and slurries in containers</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
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<td>yes</td>
<td>tm ++</td>
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<td><strong>Valves and taps</strong></td>
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<tr>
<td>Sampling tool</td>
<td>Main application</td>
<td>Application</td>
<td>Aperture (mm)</td>
<td>Sample length (cm)</td>
<td>Maximum sampling depth (m)</td>
<td>Level of disturbance</td>
<td>Fit for stratified sampling</td>
<td>Can be sterilized</td>
<td>Fit for analysis</td>
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<tr>
<td>Valve</td>
<td>Liquids under pressure</td>
<td>S C L SC/P P</td>
<td>- - +++ - -</td>
<td>- -</td>
<td>- -</td>
<td>difficult</td>
<td>tm ++</td>
<td>vol -</td>
<td></td>
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<tr>
<td>Tap</td>
<td>Liquids; particulates free flowing under gravity</td>
<td>S C L SC/P P</td>
<td>- - +++ - +++</td>
<td>- -</td>
<td>- -</td>
<td>difficult</td>
<td>tm ++</td>
<td>vol -</td>
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<tr>
<td>Thief (grain sampling device)</td>
<td>Particulates</td>
<td>S C L SC/P P</td>
<td>++ - - - + (6)</td>
<td>12-25</td>
<td>60-100</td>
<td>- -</td>
<td>yes</td>
<td>tm ++</td>
<td>vol -</td>
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<tr>
<td>Trier</td>
<td>Soft to firm soils</td>
<td>S C L SC/P P</td>
<td>++ + - + + (6)</td>
<td>12-25</td>
<td>60-100</td>
<td>++ ++</td>
<td>yes</td>
<td>tm ++</td>
<td>vol -</td>
<td></td>
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<tr>
<td>Split tube</td>
<td>Soil</td>
<td>S C L SC/P P</td>
<td>++ + - + ++</td>
<td>35-125</td>
<td>30-90</td>
<td>&lt;1 +++ +++</td>
<td>yes</td>
<td>tm ++</td>
<td>vol +</td>
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<tr>
<td>Thin-walled (Shelby) tube sampling device</td>
<td></td>
<td>S C L SC/P P</td>
<td>++ - - ++ -</td>
<td>50-100</td>
<td>25-90</td>
<td>&lt;1 +++ +++</td>
<td>yes</td>
<td>tm ++</td>
<td>vol +</td>
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<tr>
<td>Pile sampling device</td>
<td></td>
<td>S C L SC/P P</td>
<td>++ + - + ++</td>
<td>0-140</td>
<td>&lt;140</td>
<td>++ ++</td>
<td>yes</td>
<td>tm ++</td>
<td>vol -</td>
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<tr>
<td>Sampling tool</td>
<td>Main application</td>
<td>Application</td>
<td>Aperture (mm)</td>
<td>Sample length (cm)</td>
<td>Maximum sampling depth (m)</td>
<td>Level of disturbance</td>
<td>Fit for stratified sampling</td>
<td>Can be sterilized</td>
<td>Fit for analysis</td>
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<tr>
<td>S</td>
<td>Soil</td>
<td>S C L SC/P P</td>
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<td>C</td>
<td>Compost</td>
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<td>SC/P</td>
<td>Sludge cake/paste</td>
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<td>P</td>
<td>Particulate material</td>
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<td>tm / vol</td>
<td>suitable for trace metals / volatiles</td>
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<td>– /0/+/++/+++</td>
<td>a scale ranging from ‘not appropriate’ to ‘most appropriate’</td>
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</table>

**Notes**

1. Depth range can be extended by adding rod extensions
2. Sample quality depends on use and soil type. Generally acceptable if used in the manner of a cork screw and the width of the flight is at least 1.5 x diameter of the central stem
3. Depending on the material from which the sampling device is made
4. Not suitable for representative samples
5. Not suitable for viscous liquids
6. Can be difficult to retain the sample with very dry granular material
A.3 Description of sampling equipment

A.3.1 Bailers

A.3.1.1 General

Weighted depth sampling devices, pond sampling devices and column sampling devices or other sampling tubes are classified under the generic term ‘bailer’ for the purposes of this document. Their application is liquid sludge sampling.

A.3.1.2 Weighted bottle sampling devices

The sampling device consists of a glass or plastic bottle, sinker, stopper, and a line that is used to lower, raise and open the bottle and is used to sample liquids of free-flowing slurries (see Figure A.1). The bottle can either be lowered to a specified depth (e.g. to collect upper, middle and lower samples) or all-level samples can be collected, depending on the time of removal of the cork (by a sharp jerk of the chain) and the speed at which the sampling device is withdrawn. A considerable degree of skill is required to collect a representative sample using a weighted bottle sampling device. The use of weighted bottles might not be suitable for very viscous liquids. An advantage of this method of sampling is that the sampling bottle can also be used as the sample container.

A.3.1.3 Simple weighted sample can

The simple weighted sample can (see Figure A.2) can be used for sampling at various depths in all sizes of tanks. It consists of a cylindrical container (of capacity about 500 ml) made of stainless steel with a weighted base in a separate compartment and conical neck.

A wire loop is fitted to shoulders at the top of the device, with a ring at the apex through which a cord is passed and is then attached to a cork fitting the neck of the can.

The empty sampling device with the cork inserted is lowered into the liquid to the required depth. The cord is jerked to remove the cork and the can is allowed to fill with product.

A.3.1.4 Weighted cage for sample bottle

The weighted cage (see Figure A.3) is designed to contain a standard glass sample bottle (of capacity about 500 ml) and can be used for sampling at varying depths in all types of tanks. It consists of a weighted base, to which are attached three vertical straps with a retaining clip at their upper end. Two of the straps are angled and to these is fixed a wire loop with a ring at the apex.

Also attached to these straps is a wire hoop which is secured to the third strap to retain the bottle in the cage. A cord passes through the ring of the wire loop and is attached to a cork fitting the neck of the bottle.

The sampling device is operated in the same way as the weighted can.

A.3.1.5 Valve sampling cylinder (sinker sampling device)

The valve sampling cylinder (see Figure A.4) consists of an open-headed upper section and a lower section within which is a light dead weight valve seating on the base of the heavier outer screw-on unit, which secures the lower to the upper section of the sampler. The bottom valve remains open, owing to the pressure of the liquid in the valve whilst the instrument is being lowered through the liquid. This ensures that an even flow of liquid passes through the cylinder. When lowering ceases, the valve closes and a sample of liquid is drawn from the depth reached by the instrument.

Some sampling devices of this type and function incorporate a light flap valve at the head, which closes off the cylinder when the filled sampling device is raised.
A.3.1.6 Bottom sampling device

a) With spring loaded valve

This bottom sampling device (see Figure A.5a) is constructed of stainless steel and comprises a cylindrical body (capacity about 500 ml) with screw-on base and top. The base incorporates a disc valve to permit entry of the liquid into the bottom of the sampling device. The top also incorporates a disc valve to permit release of air from the sampling device.

Attached to the screw-on top is a fixed hoop, which serves to suspend the sampling device from a cord and provides a guide and spring retainer for the central valve spindle.

The valve spindle projects below the bottom of the sampling device and, when this grounds on the tank bottom, the spindle is pushed up into the cylinder against the light spring, opening first the valve in the base, followed after a short delay by that at the top. This is made possible by the small gap in the sleeve at the upper part of the cylinder. The purpose of this short delay between opening of the inlet and the outlet valves is to ensure that the liquid first enters through the base. This causes a slight increase in pressure inside the vessel which prevents liquid entering at the top, when the upper valve opens.

Buoyancy can be overcome by adding weights in the form of stainless steel annular rings which are slipped over the body of the sampling device and held in place by the screwed base.

d) With deadweight valve

This bottom sampling device (see Figure A.5b) is basically similar to the bottom sampling device with the spring-loaded valve in design and operation, except that the lower valve is kept closed by deadweight and the release of air is through a reduced section of the valve spindle at its upper end.

A.3.1.7 Column sampling device

This is one of the most commonly used sampling devices for containerized materials (see Figure A.6).

The main parts of the equipment consist of a hollow PVC tube and concentric PVC rod attached to a polychloroprene stopper, which form the sampling tube, closure locking mechanism and closure system. The sampling device is lowered into the liquid to cut across a column of liquid. Used correctly, the sampling rate should be fairly slow, with the equipment being lowered sufficiently slowly for the liquid height inside and outside the sampling tube to remain approximately equal. The sampling device is pushed against the bottom of the container to close the sampling device and locked by turning the T-handle. The sampling device is withdrawn, wiped with a disposable cloth and discharged into the sample bottle by turning the T-handle to ‘open’. Column sampling devices are manufactured from either plastic (usually PVC) or glass.

A.3.1.8 Drum and tank sampling device

A number of proprietary drum and tank sampling devices are available. They typically consist of a 1 m length of clear uPVC tube (through which the liquid can be viewed) with an automatic valve assembly and removable strainer at the base. They are used to collect a composite sample of stratified liquids (e.g. floating oils) from different depths.

A.3.1.9 Tube sampling device

The tube sampling procedure is applicable for sampling liquids in drums and cans. The tube consists generally of glass, PTFE or stainless steel. Different sized tubes (500 and 1000 ml) are used to sample drums of different capacities. The technique is crude, but effective; the tube is lowered into the liquid, sealed at the top with a (gloved) thumb and discharged into a sampling device by removing the thumb. Two rings can be attached to opposite sides of the tubes at the upper end for two fingers to slip through, leaving the thumb free to close the opening (see Figure A.7 and A.8).

By leaving the upper end open at various levels in the tank, bottom, middle, upper or all-level samples can be taken.
A.3.1.10 Pond sampling device

The pond or dipper sampling device consists of a glass, plastic or other non-reactive beaker clamped to the end of a 2 or 3 piece telescopic aluminium or fibreglass pole (see Figure A.9). Liquids and free-flowing slurries can be sampled up to 4 metres from the bank. The sampling device is inserted into the liquid upside down and inverted at the required sampling depth. When a discharge stream is sampled, the dipper should be passed through the stream at such a rate that it is filled in one pass, making sufficient passes to cover the entire cross-sectional area of the stream. The use of this type of sampling device is not advisable when the total depth of the liquid is greater than around 4 metres.

A.3.2 Pumps

A.3.2.1 General

A range of pumps are available for sampling liquids. Vacuum pumps are less suitable for sampling volatile or highly volatile material than other types as the vapour formed reduces the vacuum so the pump no longer works effectively.

A.3.2.2 Vacuum sampling device for sampling thick sludge from open vessels

For thick sludges (such as primary sludges), the vacuum sampling device (see Figure A.14) has been used successfully in circumstances such as storage tanks that have not been fitted with pipework for stratified sampling. Sample uptake pipes can be set to sample at predetermined depths from the top of the tank. Construction consists of a pipe of 25 mm bore, electrically earthed to the tank, in 2 m sections joined by screw connections which do not reduce the bore, up to a maximum of five sections. This is connected via a flexible pipe and valve to a 10 l bottle or Buchner flask which is surrounded by a guard to prevent injury should it collapse; it can be evacuated by hand or by an electrically operated vacuum pump fitted with an intrinsically spark-free motor.

It is necessary to obtain a good vacuum in the bottle before opening the valve to the sampling line. Before taking a sample, some sludge should be withdrawn into another clean 10 l bottle to flush out the pipe. The volume of the purge should be equivalent to at least three times the standing volume of the sampling arm. This method is particularly suitable for sampling from digesters, either through a port in the roof or through a sludge seal in floating head types. It is important to remove encrusted sludge from the sampling point before inserting the aluminium pipe. In order to ensure that the sample of sludge is representative, the location of the uptake tube will need careful consideration.

NOTE 1 In situations in which a very viscous layer develops in a stratified sludge, such equipment can draw up less viscous material and overlying rainwater, thus generating an unrepresentative sample.

NOTE 2 The equipment has been demonstrated to be suitable for sampling sludges with dry solids contents greater than 6% to 8% mass fraction.

A.3.3 Valves

a) Apparatus for sampling from pipes under pressure

The valve arrangement (see Figure A.15) should be connected to a system of gauges capable of measuring and equating the pressurized pipe to which it is connected. The device acts as a pressure lock to allow a controlled decompression into the sample vessel. This operation is an aid to the safe handling of the sample and considerably reduces the effects of shear on the sludge. The following steps outline the procedure:

b) Connect the apparatus to the high-pressure line at point A with all valves closed.

c) Open valve D and admit compressed air until the pressure in the apparatus is equal to the operating pressure of the filter press or pipe in question.

d) Close valve D and open valve B.
e) Slightly open valve E to allow the air to escape and sludge to be sampled through open valve B.

f) When sludge appears at the outlet valve E the sampling compartment is full of sludge. Close valve E.

g) Close valve B and open valve E to reduce the pressure to atmospheric.

h) Open valve C and withdraw the sludge sample.

To compensate for the dead volume of sludge in the pressure sampling line, the system should be purged by withdrawing and discarding a volume of sludge equivalent to at least three times the volume of the pipe. This ensures that new sludge is drawn off as the sample.

A.3.4 Augers

A.3.4.1 General

Augers can be used when there is no need for an undisturbed sample. Soils, sand, packed powders, granular material and pierceable solids can all be sampled with a soil auger.

Hand-held augers consist of an auger bit, a solid or tubular drill rod and a ‘T’ handle. The auger tip drills into the material as the handle is rotated; when the full sampling depth has been reached the auger is pulled out. The material retained on the auger bit when the auger is pulled to the surface is the sample.

A wide variety of auger bits are available, each designed for use in particular situations. Choosing the correct auger bit is essential for effective sampling. The following are types commonly used.

- Dutch auger (also called Edelman auger) (see 3.4.2);
- Spiral auger (also called screw or flight auger) (see A.3.4.3);
- Bucket auger (also called barrel, orchard, post-hole and core auger) (see A.3.4.4);
- Riverside auger;
- Stony soil auger.

A.3.4.2 Dutch auger

Soils, sand, packed powders, granular material and pierceable solids can all be sampled with a soil auger. However, the equipment might not be useful for non-cohesive solids (i.e. sandy soils etc.). An auger consists of a hard metal central shaft with sharpened spiral blades, which discharge cuttings upwards as the shaft is rotated down through the material. A disturbed sample is obtained (i.e. it is not possible to distinguish layered material taken between the surface and the base of the profile), removed from the catch-pan and bottled (see Figure A.10).

A.3.4.3 Spiral auger

NOTE Also called screw or flight auger

A spiral auger consists of a hard metal central shaft with sharpened spiral blades that discharge cuttings upwards as the shaft is rotated down through the material. The auger is used to bore a hole to the desired depth, and is then withdrawn. The sample is collected directly from the flights. Spiral augers for manual sampling are available ranging from about 2.5 to 4 cm in diameter and up to 30 cm in length (see Figure A.16a). Additional depth range can be achieved by adding rod extensions. Power-driven or drill rig-operated spiral augers are available.

The equipment is most suitable for moist cohesive soils, but might not be useful for dry or non-cohesive solids. Spiral augers might be considered unfit for sampling in some situations because of the high degree of mixing
of the sample or if volatile compounds are of interest. It can be operated by one person, but extremely high pulling forces that might be needed to extract the auger from some materials (particularly clay soils).

Spiral augers are not suitable for:

- clay soils that are highly cohesive and therefore only require an auger with narrow blades - a bit of 2.5 cm might work better than the larger ones;
- very dry or sandy soils which have little cohesion and might not adhere to the bit; wider blades might help keep the sample inside the auger;
- coarse sandy soils (and extremely dry sandy soil) which have very little or no cohesion; augers for these soils tend to have extra wings to form an almost closed auger that will effectively trap the sample.

Screw the auger vertically into the soil until the auger reaches the required sampling depth; pull the auger out of the ground; inspect the sample obtained. If there are any missing sections of soil, discard the sample and repeat the sampling process, within one metre of the original sampling point, until a sample is obtained without any missing sections.

A.3.4.4 Bucket auger

NOTE Also called barrel, orchard, post-hole and core auger

A bucket auger (see Figure A.16b) is made of a cylinder or barrel to hold the soil, which is forced into the soil by the cutting tips at the lower end. The upper end of the cylinder is attached to a length of pipe with a crosspiece for turning at the top. Although both ends of the cylinder are open, the soil generally packs so that it stays in place while the auger is pulled from the hole. Bucket augers with special closed cutting blades are available for use in sandy soils, very wet soils and very dry soils.

Bucket augers work best in loose or sandy soils and in compact soils. They are not well suited to use in wet or clayey soils, though an open-sided barrel is available that works well. They also work poorly in stony and gravelly soils. Bucket augers are available with different tips designed for specific soil types. For example, the sand auger tips are formed to touch so that very dry and sandy soils are retained. The tips of the mud auger are spaced further apart to allow for easier removal of heavy, wet soil and clays.

Bucket augers can be bulky to carry and bore more slowly than screw augers, but they are easier to remove from the soil and the sample is disturbed less.

Bucket augers should not be used for collecting samples for VOC analysis, but an acetate sleeve might be used to help integrity of VOC samples.

A.3.5 Sampling tubes

The sampling tube is a stainless steel instrument consisting of two concentric tubes closely fitted into each other throughout their entire length, so that one tube can be rotated with the other. Longitudinal openings are cut in each tube. In one position the tube is open and admits the sample and by turning the inner tube it becomes a sealed container (see Figure A.11).

The inner tube is 20 mm to 40 mm in diameter and undivided in its length. The two tubes are provided with holes to be aligned when emptying, so placed that the sample contained in the instrument can be drained through them when the longitudinal openings are closed.

The sampling tube type can be made of glass, although extreme care should be taken to avoid breakages. More usually the equipment is of stainless steel, aluminium or PTFE. It is inserted either closed by a gloved finger at the top or open, as desired. It is then closed by the finger and withdrawn.

The sampling tube can be used for taking samples at various levels from drums by keeping top closed until the required sampling depth is reached.
Volatile material quickly boils under vacuum; it is therefore advisable to use a tube with a bottom seal. The ball valve pump is highly suitable. However, it cannot be used for viscous or aggressive liquids.

A.3.6 Push sampling devices

A.3.6.1 Thief

The sampling thief or grain sampling device consists of two concentric tubes of stainless steel or brass, one fitting closely inside the other (see Figure A.13a). The outer tube has a conical pointed tip to facilitate sample penetration; the inner tube is rotated to open/close the sampling device. Samples of dry granular and powdered material can be collected where the particle diameter is less than one-third the width of the slots. The closed sampling device is inserted into the material from a point near a top edge or corner, through the centre to a point diagonally opposite the point of entry. The inner tube is rotated to open the sampling device and shaken to allow material to enter the open hatches. The sampling device is then closed and withdrawn, placed in a horizontal position (slot upward), the inner tube removed and its contents transferred to the sample container.

A.3.6.2 Trier

A trier consists of a tube cut in half lengthways, with a sharpened tip. Triers of lengths varying between 60 - 100 cm and 127 - 254 cm are available at laboratory supply stores (see Figure A.13b). They are easy to use and decontaminate.

Triers can be used to collect moist or sticky solids and consolidated soils with a particle diameter less than half the trier diameter. They can also be used for soft or loose consistency samples up to a depth of 60 cm. Triers are difficult to use in stony soils, dry sandy soils or hard clays.

Push the trier into the soil and rotate it once or twice to cut a core. Withdraw the trier, making sure the slot is facing upward, and transfer the sample to a labelled sample container. In some cases it is best to insert the trier at an angle to minimize spillage of the sample.

A.3.6.3 Pile sampling device

Where samples are in large heaps with cross-sectional diameters of 1 m or more, a much larger trier (pile sampling device) can be used.

Pile sampling devices are commercially available, but can be easily fabricated from PVC pipe. A 1.5 m length of pipe (e.g. ID 300 mm, wall thickness 0.3 mm) is sawn lengthways (with a 60/40 split) to the last 100 mm. The narrow piece is removed to leave a slot in the pipe, the slot edges are sharpened to allow the sampling device to cut into the material and the uncut end is used as a handle, this sampling device can also be used for material in bins or trucks where a normal trier is not long enough. Samples are likely to be suspect where particle diameters are greater than half the trier diameter (see Figure A.13c).

A.3.6.4 Split-tube sampling device

NOTE Also called split-barrel, split-spoon sampling device.

A split-tube sampling device (see Figure A.17) consists of a hollow tube with a circular chisel or cutting shoe threaded onto one end and a driving head or collar threaded onto the other end. The split-tube has a hinge at the top that allows the tube to open and close along its length. This facilitates sample removal and equipment decontamination.

Split-tube sampling can be used to collect undisturbed sample cores up to 60 cm in length. The split-tube is driven in to its sampling depth and the core extracted.
A.3.6.5 Tube sampling device

A tube sampling device consists of a ‘T’ handle and a tube with a cutting tip. A variety of cutting tips are available, designed for different soil types. The tube is pushed into the soil then withdrawn, and the sample is collected.

A variety of tube sampling devices are available, including soil probes, thin-walled tubes and soil recovery probes. Soil recovery probes are used with reusable liners to minimize contact with air, which makes them suitable for collected samples for VOC analysis.

The equipment for the tube sampling device is portable and easy to use. Tube sampling devices are considered better than augers because samples are collected in a continuous core through the entire sampling depth with minimal disturbance of the soil.

Tube sampling devices are not suitable in all situations. In non-cohesive soils sample retention can be a problem. In overly wet soils soil compression can be a problem, but if the soil is too dry it can be difficult to penetrate.

A.3.7 Spoons, Spades, Scoops

A.3.7.1 Scoops

Dry granular materials in bins or other shallow containers or on conveyor belts can be sampled using a laboratory scoop or shovel. A polypropylene scoop is preferable, being resistant to corrosion and chemical reaction and disposable. Figure A.12 shows the design of the scoop, and Table A.2 gives the dimensions of the scoop for particles of different sizes.

NOTE From the viewpoint of bias, scoops with sides are preferable to shovels in that large particles tend to roll off the heap which is formed on a shovel.

A.3.7.2 Trowel

Trowels are often used to sample soil, but these tools cannot be used to extract a sample from the full depth to produce an unbiased soil sample. They should not be used for collecting representative soil samples, although they can be used for homogenising and sub-sampling.

A.3.7.3 Spade or shovel

A flat-bladed, square-edged spade or shovel can be used. However, careful sampling is necessary to extract a sample from the full depth of the soil to produce an unbiased sample. This method is only suitable for cohesive soils.

To take a sample, make a ‘V’ shaped cut into the soil to the required depth (see Figure B.3). Shave a slice, 2-3 cm thick, from one side of the hole to the full sampling depth with the spade. Use the centre portion of the slice, 2-3 cm wide, for the sample carefully taking away unwanted material from either side of a vertical slice on the blade. Transfer the remaining central portion to the sample container.
Key

1 Clean cotton twine

Figure A.1 - Weighted bottle sampling device for liquids [after ASTM E300-70, 1973]
Figure A.2 - Simple weighted sample can [ISO 5555]
Figure A.3 - Weighted cage for sample bottle [ISO 5555]
Figure A.4 - Valve sampling cylinder (sinker sampling device) [ISO 5555]
Figure A.5 - Bottom sampling device [ISO 5555]
Figure A.6 - Column sampling device [after USEPA 1994]
Figure A.7 - Sampling tubes [ISO 5555]
Key

1 Tube (glass, PTFE or stainless steel)

Figure A.8 - Probe: slotted tube sampling device [NVN 5860]
Figure A.9 - Construction of a pond dipper/sampling device for liquid sludges [after USEPA 1994]

Key
1 = Varigrip
2 = Beaker 150 ml to 600 ml
3 = Bolt Holes
4 = Telescoping Aluminium Pole 2.5 m to 4.5 m (8 to 15 ft)
Figure A.10 - Soil auger [NVN 5860]
Figure A.11 - Sampling tubes [ISO 5555]
Table A.2 — Recommended sizes of scoops [ISO 11648-2:2001]

<table>
<thead>
<tr>
<th>Nominal top size of material (mm)</th>
<th>Recommended dimensions (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.2</td>
<td>75  35  30</td>
</tr>
<tr>
<td>16.0</td>
<td>110 50  40</td>
</tr>
<tr>
<td>22.4</td>
<td>170 70  50</td>
</tr>
<tr>
<td>31.5</td>
<td>220 95  80</td>
</tr>
<tr>
<td>45.0</td>
<td>300 135 120</td>
</tr>
</tbody>
</table>

NOTE Scoops are not suitable for sampling bulk material with a nominal top size larger than about 45 mm.
Figure A.13 – Sampling devices for solid materials a) thief, b) trier and c) pile sampling device [after USEPA 1980]
Key

1 To vacuum
2 10 litre sample bottle
3 Support
4 Protective covering
5 Electrical ground to tank
6 25 mm bore

Figure A.14 – Apparatus for the sampling of thick liquid sludge under vacuum [EN ISO 5667-13]
Key

1 Compressed air
2 PVC pipe 15 mm o.d.
3 High pressure sludge line
4 Container
5 PVC pipe 30 mm o.d.
6 Sample collecting container

A High-pressure line connection point
B Sludge sampling valve
C Sample delivery value
D Compressed air input valve
E Air escape valve

Figure A.15 – Apparatus for sampling from pipes under pressure [EN ISO 5667-13]
Figure A.16 — Sampling augers (a) Screw auger; (b) Bucket auger
Figure A.17 — Push sampling device: Split-tube sampling device
Figure A.18 Sampling with a spade

(a) Shave a slice from the side of a cleanly-dug 'V' shaped hole; (b) Use the centre portion for the sample.
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