

BS 10176:2020



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Taking soil samples for determination of volatile organic compounds (VOCs) — Specification

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Foreword

Publishing information

This British Standard is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 31 May 2020. It was prepared by Technical Committee EH/4, *Soil quality*. A list of organizations represented on this committee can be obtained on request to its secretary.

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Presentational conventions

The provisions of this standard are presented in roman (i.e. upright) type. Its requirements are expressed in sentences in which the principal auxiliary verb is “shall”.

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Where words have alternative spellings, the preferred spelling of the Shorter Oxford English Dictionary is used (e.g. “organization” rather than “organisation”).

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Introduction

BS 10175:2011+A2:2017, **8.3.2**, recommends that, when collecting samples for the determination of volatile compounds, a sampling technique is employed that minimizes the loss of volatiles. The primary purpose of BS 10176 is to set out procedures that can be followed in the field to minimize loss of volatile organic compounds (VOCs) during sampling, and thus assist in the collection of representative samples so that subsequent analytical results provide a reliable basis for estimation of potential risks. These procedures are presented as requirements which need to be strictly adhered to in order to provide reliable and repeatable results.

The specified procedures amplify those in BS EN ISO 15009, [BS EN ISO 16558-1](#), BS ISO 18512 and [BS EN ISO 22155](#) for the application of the methanol immersion method and introduces procedures for application of the sodium hydrogen sulfate (sodium bisulfate) solution immersion method, and for immersion in de-ionized water.

VOCs are flammable and typically toxic, carcinogenic, narcotic or otherwise harmful to humans and other biota and terrestrial and aquatic ecosystems, and can cause degradation of certain man-made materials, including plastics. Human exposure can be through inhalation, ingestion (direct and indirect) and dermal contact.

An understanding of how VOCs might be present in soil, their distribution between soil phases, and how they can behave in soil is important to understanding how reliably measurements of concentrations in soil are likely to provide a realistic picture of potential risks in any particular situation.

Research has shown that if soil samples for the determination of VOCs are taken and handled incorrectly in the field and laboratory most, if not all, of the volatiles present can be lost. Even under ideal laboratory conditions, there can be substantial losses [1-3] (see [Annex A](#) for a summary of the research in references [2] and [3]).

The procedures in this British Standard require careful consideration when planning a ground investigation, taking account of the conceptual model, the objectives of the investigation, the subsequent risk management approach for the site, and the practical implications. It might be necessary to take into account that the immersion methods described in this standard can require considerable time, resources, competent oversight and quality control. They introduce potential health risks due to the chemicals required during transport, site work and in the laboratory. In addition, certain operational sites might not permit the use of the procedures due to the nature of the chemicals required to be used on site.

1 Scope

This British Standard specifies methods for taking soil samples for the determination of volatile organic compounds (VOCs) to minimize the possible loss of VOCs to atmosphere during and after sample collection.

Two principal ways of taking samples for VOC determination are specified:

- a) an intact core sealed to prevent loss of VOCs is taken and sent to the laboratory; and
- b) a small portion of material taken with a coring device is immediately placed in water or a preservative (e.g. methanol or sodium hydrogen sulfate) in a subsequently sealed vial to be sent to the laboratory.

The methanol immersion method described amplifies the guidance in BS EN ISO 15009, [BS EN ISO 16558-1](#), BS ISO 18512 and [BS EN ISO 22155](#) about this method and is intended to be followed in preference to the briefer descriptions in these four standards.

NOTE 1 This standard uses the term "soil" to refer to "soil and soil materials" as defined BS EN ISO 11074:2015, 7.4.16, although the procedures specified might not be applicable to certain coarse soils and rocks (see [4.1.2](#), [Figure 1](#) and [6.3](#)).

NOTE 2 The methods described can be applied at the sampling location, in an on-site facility or at an off-site facility. In all three cases, the sample is then sent to the analytical laboratory. It is assumed that the overall site investigation is carried out in accordance with [BS 10175](#) and that the sampling strategy is developed in accordance with [BS 10175](#) and BS ISO 18400-104.

NOTE 3 Analytical procedures are outside the scope of this standard. Laboratories should adopt procedures that will yield accurate results for the sample as presented to the laboratory. The sampling methods described are suitable for use in connection with, amongst others, the analytical methods described in:

- *BS EN ISO 15009, Gas chromatographic determination of the content of volatile aromatic hydrocarbons, naphthalene and volatile halogenated hydrocarbons – Purge-and-trap method with thermal desorption;*
- *[BS EN ISO 16558-1](#), Risk-based petroleum hydrocarbons – Determination of aliphatic and aromatic fractions of volatile petroleum hydrocarbons using gas chromatography (static headspace method);*
- *[BS EN ISO 22155](#), Gas chromatographic determination of volatile aromatic and halogenated hydrocarbons and selected ethers – Static headspace method.*

Observations and recommendations regarding analytical procedures in commentaries and notes are provided for information only.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes provisions of this document¹⁾. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

[BS 5930](#), *Code of practice for ground investigations*²⁾

[BS 8576](#), *Guidance on investigations for ground gas – Permanent gases and Volatile Organic Compounds (VOCs)*³⁾

BS 10175:2011+A2:2017, *Investigation of potentially contaminated sites – Code of practice*

¹⁾ Documents that are referred to solely in an informative manner are listed in the Bibliography.

²⁾ This standard also gives an informative reference to BS 5930:2015.

³⁾ This standard also gives informative references to BS 8576:2013.

[BS EN ISO 11074](#), *Soil quality – Vocabulary*⁴⁾

[BS ISO 18400-102](#), *Soil quality – Sampling – Part 102: Selection and application of sampling techniques*⁵⁾

[BS ISO 18400-103](#), *Soil quality – Sampling – Part 103: Safety*

[BS ISO 18400-105](#), *Soil quality – Sampling – Part 105: Packaging, transport, storage and preservation of samples*

[BS ISO 18400-106](#), *Soil quality – Sampling – Part 106: Quality control and quality assurance*

[BS ISO 18400-107](#), *Soil quality – Sampling – Part 107: Recording and reporting*

[BS ISO 18512](#), *Soil quality – Guidance on long and short term storage of soil samples*⁶⁾

3 Terms and definitions

For the purposes of this British Standard, the terms and definitions given in [BS 8576](#), [BS 10175](#) and [BS EN ISO 11074](#) and the following apply.

3.1 anthropogenic ground

deposits which have accumulated through human activity

NOTE These could consist of placed/replaced worked natural materials, e.g. clay, or man-made materials, e.g. refuse.

[SOURCE: BS 5930:2015, 3.1/ BS ISO 18400-104:2018, 3.2, modified]

3.1.1 made ground

anthropogenic ground in which the material has been placed without engineering control and/or manufactured in some way, such as through crushing or washing, or arising from an industrial process

[SOURCE: BS 5930:2015, 3.10, modified]

3.1.2 fill

anthropogenic ground in which the material has been selected, placed and compacted in accordance with an engineering specification

[SOURCE: BS 5930:2015, 3.4]

3.2 coring tube

instrument used to obtain a cylindrical core of soil for analysis

3.3 data quality objectives (DQO) process

systematic planning approach which defines the type, quantity and quality of data that are needed to inform decisions

[SOURCE: National Environment Protection Council of Australia [4]]

3.4 internal standard

number of chemicals of known concentrations added to a sample to allow the concentration of compounds within the sample to be quantified

NOTE Each internal standard is used to quantify a specific group of VOCs.

⁴⁾ This standard also gives informative references to BS EN ISO 11074:2015.

⁵⁾ This standard also gives informative references to BS ISO 18400-102:2017.

⁶⁾ This standard also gives an informative reference to BS ISO 18512:2007.

3.5 rock

naturally occurring assemblage of minerals, crystallized, consolidated, cemented, or otherwise bonded together, so as to form material of generally greater strength or stiffness than soils

[SOURCE: BS 5930:2015, 3.12]

3.6 sampling technique

appropriate procedures and sampling devices to obtain and describe samples of soil or soil material, either in the field or during transportation and in the laboratory

NOTE The manner of selection of the sampling technique is to be described in the sampling plan.

[SOURCE: BS EN ISO 11074:2015, 4.4.29]

3.7 soil

assemblage of mineral particles and/or organic matter which can be separated by gentle mechanical means and which includes variable amounts of water and air (and sometimes other gases)

NOTE 1 The term is also applied to anthropogenic ground consisting of replaced natural soil or man-made materials exhibiting similar behaviour, e.g. crushed rock, blast furnace slag, fly-ash.

NOTE 2 Soils might have structures and textures derived from rock but are usually of lower strength than rocks.

[SOURCE: BS 5930:2015, 3.13]

3.8 undisturbed sample

sample obtained from the soil using a method designed to preserve the soil structure

[SOURCE: BS EN ISO 11074:2015, 4.4.31]

3.9 volatile organic compound (VOC)

organic compound that is volatile under normal environmental/atmospheric conditions, although it can be found in the ground in the solid, liquid and dissolved phase forms as well as in the gaseous phase

NOTE The volatility of an individual compound is a function of the vapour pressure (see [Annex B](#)).

[SOURCE: BS 8576:2013, 3.15, modified; originally from CIRIA Report C682 [\[5\]](#)]

4 Soil sampling

COMMENTARY ON CLAUSE 4

When the concern is for risks to human health, the potential for release to the water environment, or the potential for attack on building materials, accurate measurements of concentrations of VOCs in the ground are required (i.e. as close to the actual concentration in the ground as possible) with minimal bias as would arise from loss of VOCs prior to the analysis being carried out. If soil samples for the determination of VOCs are taken and handled incorrectly in the field and laboratory most, if not all, of the VOCs present can be lost. Research has shown that, even under ideal conditions, there can be substantial losses [\[1-3\]](#).

When the purpose of an investigation is to assess the risks to human health and safety from inhalation or due to the presence of flammable vapours, risk assessments can be based on the concentrations measured in the soil vapour phase or in the atmosphere of interest (e.g. in a confined space), but it is usual to also measure VOCs in groundwater and soil. Soil vapour concentrations can be determined following the procedures described in [BS 8576](#). Relevant guidance is also provided in CIRIA Report C682 [\[5\]](#).

BS 10175:2011+A2:2017, 8.3.2, states that when collecting samples for the determination of volatile compounds the sampling technique employed should minimize the loss of volatiles. It is noted that a methodology for the collection of soil samples to minimize loss of volatiles is given in BS ISO 18512 (this is a reference to immersion in methanol).

The intention of BS 10176 is to provide procedures which, if followed correctly, help to minimize loss of VOCs and thus ensure that analytical results are sufficiently representative of ground conditions and with minimal avoidable bias.

The selection of analytical methods is outside the scope of this standard but because measured VOC concentrations can vary as a function of the soil sampling, transport and laboratory analytical methodology, it is important to discuss the sampling techniques to be used with the laboratory in advance of sampling.

In most instances when VOCs in soil are the subject of investigation it is necessary to make decisions regarding:

- a) what VOCs to look for having regard to the results of the preliminary investigation, including the conceptual site model (CSM)) and the objectives of the overall investigation;*
- b) where to look for the VOCs of interest;*
- c) required analytical data quality objectives (DQOs), including detection limits (these might depend on why the investigation is being carried out) – see [Clause 5](#);*
- d) analytical method(s) that will meet the DQOs;*
- e) what sampling method(s) to use – see [Clause 6](#);*
- f) what sampling device(s) to use – see [Clause 7](#);*
- g) how to use the selected device(s) – see [Clause 7](#); and*
- h) how to access the material to be sampled/bring material to the surface for sampling – see [Clause 8](#).*

Elements a), b) and e) to h) are steps in the overall process of developing the sampling plan for VOCs.

It is also necessary to make decisions about:

- how samples are to be handled on site, transported to the laboratory, and handled/stored at the laboratory – see [Clause 9](#) to [Clause 11](#);*
- QA/QC procedures – see [Clause 12](#);*
- data evaluation – see [Clause 13](#); and*
- reporting and recording – see [Clause 14](#).*

In many site investigations, information is required not only on VOCs but also semi-volatile organic compounds (SVOCs) and a range of other halogenated and non-halogenated organic compounds. In such circumstances, an overall sampling plan is required so that all the representative samples can be collected for all the determinations required, preferably in a single on-site operation.

4.1 Soil sampling strategy

4.1.1 General

COMMENTARY ON 4.1.1

It is assumed that, for the purposes of this standard, a soil sampling strategy (e.g. where to sample, what to sample, how to sample, how many samples to take) has been established in accordance with [BS 10175](#) and BS ISO 18400-104, with particular attention to the following:

- a) VOCs are most likely to be present due to spillages and leaks, etc.;*
- b) VOCs can be present in solution in water, in the vapour phase, sorbed to the soil particles, present between particles as a non-aqueous phase liquid (NAPL) or present as a component of an NAPL;*
- c) VOCs can be preferentially associated with soil organic matter, including plant remains, or preferentially present in finer soil fractions;*
- d) concentrations of VOCs are likely to vary markedly in soils of different types (e.g. sands, clays); and*
- e) concentrations of VOCs can vary by orders of magnitude over very short distances (e.g. a few centimetres).*

A sampling plan shall be prepared based on the sampling strategy in accordance with BS 10175:2011+A2:2017, 5.2.5.

NOTE Soil conditions with the highest potential for vapour intrusion (dry granular soils – high vapour permeability) are also the most difficult in which to accurately measure VOC concentrations. Conversely, moist homogenous fine soils (e.g. clay) are the easiest soil types in which to accurately measure concentrations, but typically represent the lowest potential for vapour intrusion due to their low vapour permeability.

4.1.2 The sampling process

COMMENTARY ON 4.1.2

Sampling involves:

- a) gaining access to the sampling point (see [Clause 8](#));*
- b) taking the sample (see [Clause 6](#) and [Clause 7](#)); and*
- c) storage, handling and transport of the sample to the laboratory where the analysis is to be carried out (see [Clause 9](#) and [Clause 10](#)).*

This overall process constitutes the “sampling technique” ([3.6](#)).

How the analytical results are to be used, including their comparison with generic assessment criteria, is outside the scope of this standard. Assessment usually involves multiple lines of evidence, including soil vapour measurements, visual and olfactory observations and site-based measurements [e.g. using a photo-ionization detector (PID)], to supplement laboratory data. Particular attention should be paid to the likely small-scale variations in concentrations and how VOCs might have become present.

When the aim is to determine VOCs, accessing the “sampling point” usually involves bringing material to the surface, or otherwise exposing it, so that one of the sampling methods described in [Clause 6](#) can be employed to obtain the sample to be sent to the laboratory.

Samples for the determination of VOCs shall be collected and transferred to the laboratory where measurements are to be made following the process in [Figure 1](#).

Analytical data quality objectives (DQO) in terms, for example, of the limits of detection required, accuracy, and analytical variability of the results, shall be set in advance of sampling in consultation with the analytical laboratory (see [Clause 5](#)).

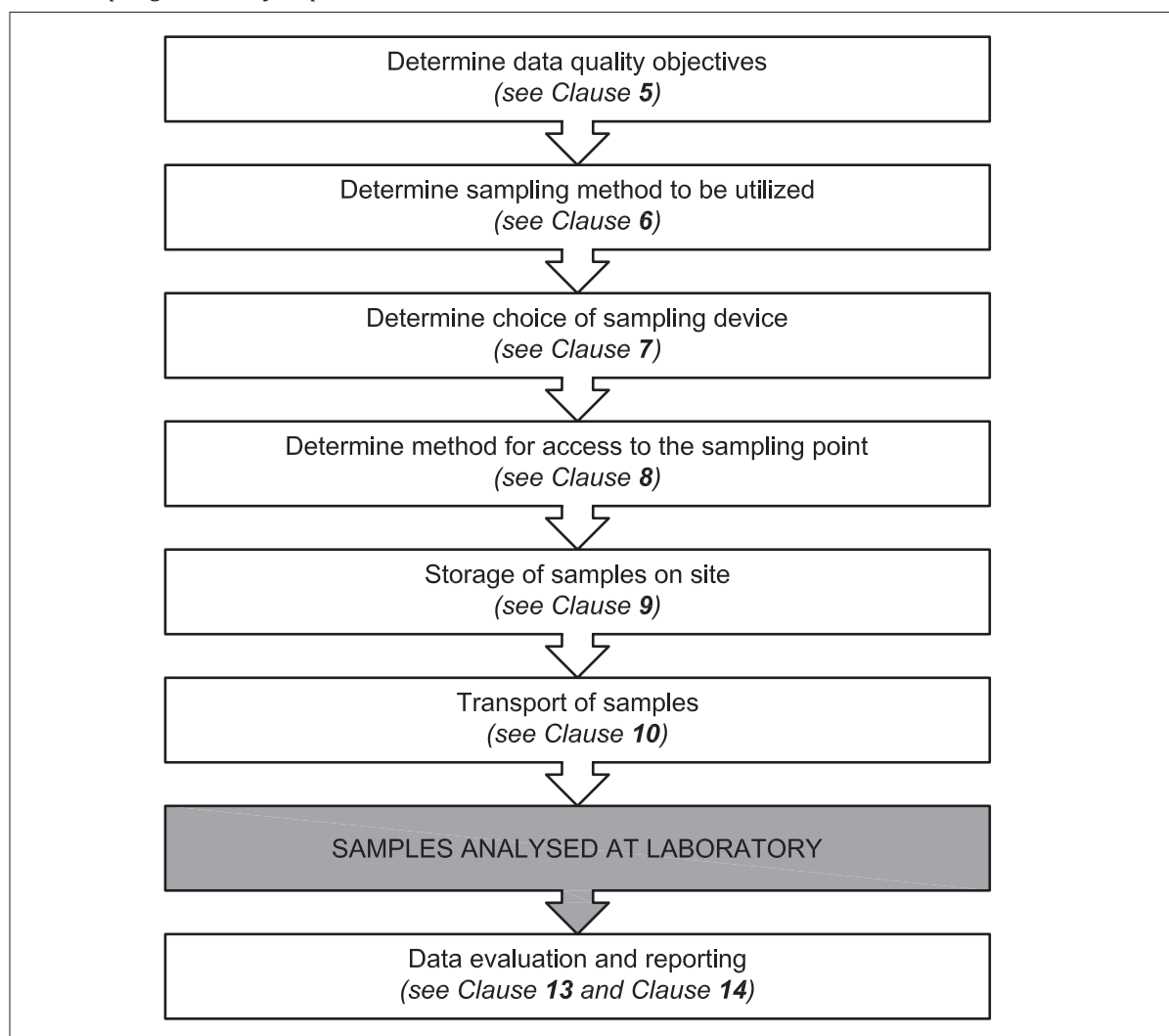
NOTE Field observations (e.g. visual, olfactory, PID) should always be undertaken and documented, and assessed in conjunction with laboratory analytical data, with any possible correlations made and included in reports.

The means used for gaining access to the sampling point (see [Clause 8](#)) and for taking the sample (see [Clause 6](#)) shall be chosen in accordance with [BS ISO 18400-102](#), with particular attention to:

- 1) health, safety and environmental considerations; and
- 2) minimizing the loss of VOCs.

On completion of the analysis the results shall be evaluated by a suitably-qualified person in terms of “fitness for purpose” in relation to any intended subsequent assessment or other use of the data (see [Clause 13](#)).

Figure 1 — Soil sampling and analysis process



4.2 Health and safety

4.2.1 General

COMMENTARY ON 4.2.1

The health and safety risk assessment is based on the conceptual site model available at the time: initially on the results of a preliminary investigation in accordance with BS 10175:2011+A2:2017 (see also BS ISO 18400-202) and subsequently on the results of field investigation carried out to date.

The applicable provisions for health and safety for site investigation and soil sampling in [BS ISO 18400-103](#), [BS 10175](#) and [BS 5930](#) shall be followed.

A health and safety risk assessment shall be undertaken which takes account of the risks associated with the sampling techniques that are to be used, as well as other site-specific risks associated with intrusive site investigation.

Appropriate health and safety precautions shall be put in place. Both the general risks associated with soil sampling and the specific risks associated with sampling and transportation of soils containing VOCs shall be addressed.

Risks associated with sampling soils containing VOCs, which can be associated with direct contact and inhalation of toxic and potentially carcinogenic substances, shall be minimized by:

- a) appropriate design of the sampling techniques and sampling equipment; and
- b) provision of suitable personal protective equipment (PPE), such as chemical-resistant gloves, eye protection and respiratory equipment where necessary.

Appropriate training shall be given to ensure that personnel understand the precautions required when sampling soils containing VOCs and when using specific sampling methods, such as sampling into vials containing methanol or sodium hydrogen sulfate.

NOTE [BS ISO 18400-103](#) provides general guidance on safety during sampling.

4.2.2 Use of methanol (CH₃OH)

NOTE 1 Methanol is a highly toxic and flammable liquid. Exposure can be fatal for humans or cause blindness and damage to the liver, kidneys and heart if swallowed. As little as 10 ml of pure methanol can cause permanent blindness by destruction of the optic nerve. 30 ml is potentially fatal. Toxic effects from repeated overexposure have an accumulative effect on the central nervous system, especially the optic nerve. Symptoms can be delayed, become severe after 12 h to 18 h, and linger for several days after exposure.

When immersion in methanol (CH₃OH) is chosen as the sample preservation method (see [6.7](#)), its use shall be fully addressed as part of the health and safety risk assessment. Appropriate safety measures shall be put in place for the use of methanol, which include the provision of appropriate PPE, undertaking sampling in a well-ventilated area, and access to washing and first aid facilities, including the provision of an eye wash. Site personnel shall have appropriate first aid training.

Appropriate health and safety data sheets shall be provided to the site personnel.

Specific training shall be given on the handling and use of methanol.

Surplus sampling vials and reagents shall be returned to the laboratory that supplied them and/or stored in a safe and appropriate manner.

Methanol shall be transported and stored in a safe and secure manner away from sources of ignition.

NOTE 2 Attention is drawn to The Health and Safety at Work etc. Act 1974 [[6](#)], the Management of Health and Safety at Work Regulations 1999 [[7](#)], the Control of Substances Hazardous to Health Regulations 2002, as amended [[8](#)], EH40/2005 Workplace Exposure Limits [[9](#)] and the CDM Regulations 2015 [[10](#)].

4.2.3 Use of sodium hydrogen sulfate (NaHSO₄)

NOTE 1 Sodium hydrogen sulfate is an acid mineral salt.

When immersion in a sodium hydrogen sulfate (sodium bisulfate) solution is chosen as the sample preservation method (see [6.8](#)), its use shall be fully addressed as part of the risk assessment. Appropriate safety measures shall be put in place for the use of sodium hydrogen sulfate, which include the provision of appropriate PPE, undertaking sampling in a well-ventilated area, and access to washing and first aid facilities, including the provision of eye wash. Site personnel shall have appropriate first aid training.

Appropriate protection measures shall be put in place when handling sodium hydrogen sulfate, including the provision of PPE to prevent contact with skin and eyes.

Appropriate health and safety data sheets shall be provided to the site personnel by the laboratory supplying the sampling equipment.

Surplus sampling vials and reagents shall be returned to the laboratory that supplied them and/or stored in a safe and appropriate manner.

NOTE 2 Attention is drawn to *The Health and Safety at Work etc. Act 1974* [6], *the Management of Health and Safety at Work Regulations 1999* [7], *the Control of Substances Hazardous to Health Regulations 2002*, as amended [8], *EH40/2005 Workplace Exposure Limits* [9] and *the CDM Regulations 2015* [10].

5 Data quality objectives (DQOs)

COMMENTARY ON CLAUSE 5

The data quality objectives process refers to a systematic planning procedure for environmental data collection so that the data can be defensibly interpreted, and statistically analysed where appropriate, to address specified objectives. It involves appropriate sampling design and sampling plans, as well as the analytical strategy and setting analytical data objectives. The concept applies not just to numerical data, but also to the sufficiency of all relevant information in terms of quantity, quality and type.

Guidance on aspects of analytical performance, such as accuracy, precision, bias and variability, is provided in BS 10175:2011+A2:2017, Annex G.

The analytical strategy (typically comprising what samples to analyse, what to analyse for and how to carry out the analyses) is outside of the scope of this standard. However, because there is an interaction between the method of sampling and the subsequent analyses, the designer of the sampling programme needs to be aware of the analytical strategy in advance of sampling being planned and carried out.

In land contamination investigations there are typically DQOs that require laboratory analytical data to be meaningfully comparable to a variety of risk-based or other quality criteria. However, the setting of analytical DQOs is outside of the scope of this standard.

DQOs shall be set for any investigation. They shall be defined for the specific purpose of the site investigation phase or activity, e.g. risk-based assessment (human health and controlled waters), remediation, validation or waste classification.

When setting DQOs, account shall be taken of the type, quantity and quality of the data required to inform subsequent decisions based on the data and other available information.

DQOs shall be set having regard to QA/QC requirements and how comparison with risk-based or other criteria are to be effectively supported by the site data/information and the laboratory analytical data collected.

Review points shall be identified at key stages throughout the investigation, assessment and remediation design phases to ensure that DQOs remain aligned to the project requirements. The review shall include assessment of the continuing validity of the conceptual site model (CSM), data consistency, emerging data gaps and levels of uncertainty. A written record of the review shall be maintained and incorporated in the assessment and design process and include a statement on whether the DQOs have been met and any shortfalls within the assessment.

NOTE 1 When defining the laboratory's maximum analytical detection limits for particular VOCs, the DQO process should include defining acceptable limits for quality assurance/quality control (QA/QC) samples in terms of their frequency, as well as acceptable concentrations of defined chemicals in field blanks, rinse blanks, trip spike samples and laboratory method blanks (see also [Clause 12](#) and [Clause 13](#), and [BS ISO 18400-106](#)).

NOTE 2 Any requirement for duplicate sampling (see [6.7.3](#) and [6.8.3](#)) and the definition of acceptable limits for relative percent differences (RPDs) between duplicate samples can also be a DQO output to be accounted for prior to the sampling event. However, because of the possibly large differences in VOC concentrations over short distances, it is not always possible to take “true” duplicate samples.

NOTE 3 The analytical limit of detection is important to determining whether a substance is present in an analytical sample. However, failing to detect a substance in the analytical sample does not mean that it is/was absent in the field sample taken from the ground or in the ground where the field sample came from. If 90% of the VOC originally present has been lost, then the field detection limit will be at least ten times the analytical detection limit. Hence the need to adopt procedures designed to minimize loss of volatiles during sampling and transport, etc., such as those described in this standard. By adopting appropriate QA/QC procedures it might be possible to estimate losses during various stages of the overall sampling-analysis process but there can never be certainty about the reliability of any particular result. Thus, there can be considerable uncertainties even without taking into account factors a) to e) in the commentary on [4.1.1](#).

6 Sampling methods

COMMENTARY ON CLAUSE 6

There are two principal ways of taking samples for VOC determination:

- a) a small intact core sealed to prevent loss of VOCs is taken and sent to the laboratory (see [6.6](#)); and*
- b) a small portion of material taken with a coring device is immediately placed in water or a preservative (e.g. methanol or sodium hydrogen sulfate) in a subsequently sealed vial to be sent to the laboratory (see [6.7](#) to [6.9](#)).*

Purpose-made sampling devices can be used, or they can be improvised provided they meet the requirements of [7.1](#).

When analytical results for VOCs properly representative of field conditions are required, it is not acceptable to take a sample using, for example, a trowel or similar device, and then to place it in a container, however rapidly this is done. Such samples might, though, be required for other purposes or where coarse-grained soils are to be sampled (see [Annex C](#) for a description of such a procedure).

It might sometimes be necessary to apply both methods (i.e. use of methanol and use of sodium hydrogen sulfate) when sampling at a particular location, to possibly take a sample into pure water, and to take replicate samples. In addition, a separate unpreserved sample is always required for determination of dry matter/moisture content (see [6.10](#)).

Some laboratories can provide kits containing sampling devices and prepared sample containers (usually 40 ml vials) for use in individual sampling events.

A study by a UK laboratory has shown that, except for a few VOCs, the methanol immersion method can provide limits of detection compatible with generic assessment criteria commonly used in the UK (see [Annex D](#)).

6.1 Use of off-site facility

If an off-site sampling facility is used, the core or other material to be sampled shall be appropriately managed to ensure integrity of the sampling process.

6.2 Choice of sampling method

The sampling method to be used shall be chosen taking into account:

- a) the objectives of the investigation;
- b) the requirements of the laboratory carrying out the analysis;
- c) the concentration range of interest;

- d) the nature of the soil or other material to be sampled (see [6.3](#)); and
- e) the practicality of application on a site-specific basis.

6.3 Influence of soil characteristics on choice of sampling method

COMMENTARY ON 6.3

Soil characteristics (especially particle size distribution) are important for the selection of the means of access to the material to be sampled (see [Clause 8](#)) and for the choice of sampling method once access has been gained. This subclause deals only with the latter.

When developing an investigation and sampling strategy specific to VOCs, a sampling method, including a sampling device appropriate to the physical nature of the soil, shall be selected in accordance with [Table 1](#) to optimize the retention of VOCs within the sample.

NOTE 1 For the purpose of sampling for VOCs, no distinction is made between natural and anthropogenic soils. For the purposes of obtaining samples for VOC analysis, it is appropriate to examine soils on the basis of their particle size distribution. These properties affect ease of penetration of the material to be sampled with the chosen sampling device and the retention of material in the sampling device.

NOTE 2 A representative sample can only be obtained if the orifice of the sampling device exceeds three times the diameter of the largest particle to be sampled. Thus, if the sampling device has an internal diameter of 10 mm, the maximum grain size of the material to be sampled should not exceed 3 mm.

NOTE 3 Soils can be encountered, especially within anthropogenic ground, that comprise highly mixed and variable media, e.g. exhibit a wide range of particle sizes. Such materials require specific consideration as to whether and how they can be sampled, e.g. selective sampling of fine fractions or organic-rich fractions as a possible worst case for VOCs, taking account of the proportion of the material being sampled in the bulk medium.

6.4 Sampling devices

Sampling devices shall meet the requirements of [7.1](#).

6.5 Sampling station

COMMENTARY ON 6.5

Sampling in accordance with this standard usually requires good working conditions, as far as possible shielded from the weather (rain, wind, hot sun, etc.) at a designated location (sampling station). It requires dexterity, careful attention to the detailed application of the procedures and careful recording of everything that is done. It might be necessary to carry out check-weighing of prefilled vials, for example.

A sampling station shall ordinarily be established so that:

- a) the material to be sampled can be accessed;
- b) equipment can be laid out;
- c) equipment can be cleaned if necessary;
- d) samples can be transferred to temporary on-site storage;
- e) samples can be prepared for transport off site; and
- f) all operations and observations can be recorded (see [Clause 14](#)).