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BS ISO 18400-104:2018
Soil quality — Sampling —Strategies

1 Scope

This document gives general guidance on the development of site investigation strategies and detailed guidance on the development of sampling strategies, when collecting information on

— the average properties of soil,

— the variability of soil properties, and

— the spatial distribution of soil properties.

It is applicable to soil samples intended for chemical testing and determination of a variety of other properties (e.g. physical).

Although the main focus of this document is the collection of material (field samples) for transfer to a laboratory for testing, it is also applicable when measurements are made directly in the field.

NOTE 1 This document also provides information on the statistical principles underlying the development of appropriate sampling strategies and statistical methodologies.

NOTE 2 Guidance on other forms of related sampling activities are given in other International Standards [for soil gas (ISO 18400-204) and for biological testing purposes (ISO 18400-206)]. Guidance on sampling groundwater is provided in ISO 5667-11 and ISO 5667-22 and on sampling methods and groundwater measurements in geotechnical investigations in ISO 22475-1.

Introduction

This document is part of a series of sampling standards for soil (the role/position of the individual standards within the total investigation programme is shown in Figure 1). It provides guidance on the development of site investigation strategies in general (more specific guidance is given in other standards) and of sampling strategies [e.g. what to sample, where to sample (locations and depths) and the types of samples to take] taking into account the need to obtain representative samples and to have regard to relevant statistical principles.

Soils (and other soil materials) are composed of a mixture of mineral particles, organic matter, water, air (soil gas) and living organisms. In the case of some contaminated soils, a non-aqueous liquid phase might also be present. The solid matrix (phase), consists of particles of different size, shape and physical and chemical properties. The aim when carrying out soil sampling is usually to obtain sufficiently representative samples that can be used to characterize the properties of the whole soil entity (e.g. *in situ* soil in the form of a volume or horizon, or surface deposit such as a stockpile) or the portion considered relevant to the objectives of the investigation (e.g. <0,1 mm fraction for exposure assessment via hand-to-mouth activity). The properties of discrete entities such as individual soil particles are not addressed. As the soil as a whole cannot be analysed, soil samples are taken instead. The assumption that the results of these investigations on samples represent the total soil volume of interest is always an approximation, the reliability of which depends on additional information about the soil, the site and use of an appropriate sampling strategy. In other words, the sampling strategy should guarantee that, together with

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additional information (on-site observations, background information, previous investigation results, etc.), the results for the samples analysed allow a model to be developed of relevant properties of the soil volume of interest to a sufficiently reliable degree, in accordance with the investigation objectives.

Whatever the purpose of the investigation, a sound conceptual site model is required. Every property of a soil or soil material is a result of their dynamic development influenced by natural and human-induced processes such as weathering, leaching, dislocation, contamination, and many others. Without considering this, the results of any investigation of samples cannot be interpreted and evaluated properly. When spatial variability of soil properties (including contamination) is of particular interest, the conceptual site model includes what is known, or believed to be known, about the processes that led to the anticipated spatial distribution of properties.

The sampling strategy, especially when average properties are of interest, is preferably based on statistical methods, as far as practical and appropriate.

Having first defined key elements such as involved parties, objectives, properties of interest, phase of the investigation, background and site information, as well as health and safety aspects, a sampling strategy is developed that can form the basis of a sampling plan in accordance with ISO 18400-101 (the sampling plan covers a number of practical issues as well as the sampling strategy).

The appropriate sampling strategy in any particular case depends on

— the objectives of the investigation,

— the special situation and characteristics of the material to be sampled,

— the properties of interest, and

— the required degree of precision and reliability of the results.

Many other factors can also influence the design of the sampling strategy including:

— accessibility of the site as well as the sampled material;

— financial, personnel, and technical resources;

— weather conditions;

— the time schedule/frame;

— legal/environmental restrictions.

Following the definition of the sampling approach, the appropriate sampling techniques are selected following the guidance in ISO 18400-102 with regard to health and safety (ISO 18400-103) and various practical considerations. The decisions made regarding sampling techniques form part of the sampling plan.

BS ISO 18400-202:2018
Soil quality — Sampling —Preliminary investigations

1 Scope

This document provides guidance on the design and execution of preliminary investigations comprising desk studies and site reconnaissance, and where appropriate, preliminary risk assessment. It is applicable whenever sampling exercises or investigations are to be carried out to determine soil quality.

Introduction

All investigation programmes to gather information about soil quality need some basic information about the subject site and its environmental setting to allow appropriate planning of the field work. To collect this information, a preliminary investigation is carried out comprising desk studies, retrieval of data from archives and databases, interviews and a site reconnaissance. From the information gathered, and the observations made, a conceptual site model can be developed including hypotheses about soil characteristics and their possible spatial distribution.

It is for the user of this document to decide the extent and nature of information required in any particular case taking into account the nature of the site and the objectives of the overall investigation: however, some preliminary information will always be needed. Detailed guidance is provided in the document based mainly on the need to obtain detailed information on many aspects of a site in the more complex cases, e.g. a potentially contaminated site, but the guidance is intended to be helpful when preparing to investigate all types of site.

The sources of information available for use in preliminary investigations will vary from country to country and jurisdiction to jurisdiction and, thus, the guidance given about sources of information in this document is of necessity generic in character. The user will find it useful to prepare detailed information about local sources for their own use. National standards providing guidance on the design and execution of geotechnical investigations often contain a requirement that a desk study and site reconnaissance should be carried out and thus could provide useful guidance about potential sources of information. Similarly, standards covering the demolition and dismantling of old buildings and industrial plant could provide useful information and guidance.

This document deals only with the investigation of the ground. It should be recognized that there could be derelict buildings and/or industrial plants awaiting demolition, dismantling or refurbishment on old urban and industrial sites, but that buildings in a poor state and containing potentially hazardous materials could also be present on farms and similar sites. Failure to investigate these buildings before demolition could put the safety of workers at risk or lead to the spread of contamination on and around the site[7][8]. The investigation of derelict buildings or remnant foundations is outside the scope of this document.

This document is part of a series on sampling standards for soil. The role/position of the standards within the total investigation programme is shown in Figure 1.

BS ISO 18400-203:2018
Soil quality — Sampling — Investigation of potentially contaminated sites

1 Scope

This document gives guidance on the:

— investigation of sites, where either it is known that soil contamination is present, or the presence of
soil contamination is suspected;

— investigation of sites where no soil contamination is expected, but the soil quality is to be determined (e.g. to make sure that there is no contamination present);

— investigation in anticipation of a need to manage re-use or disposal of excavated soil which might be
contaminated;

— collection of information that is necessary for risk assessment and/or the development of remedial action plans (e.g. whether remediation is required and suggestions as to how this might be best achieved).

Although the information on soil quality for the risk assessment and/or the development of remedial action plans is gathered by applying this document, it does not give guidance on the decisions and actions that follow from a site investigation, for example, risk assessment and decisions about the requirements for remediation (if any).

Introduction

This document is one of a series of standards dealing with various aspects of site investigation and sampling. It is intended to be used in conjunction with the other parts of the ISO 18400 series. The role/ position of the individual standards within the total investigation programme is shown in Figure 1.

While serious cases of soil contamination mostly occur on urban and industrial sites, serious contamination of agricultural land can also occur (for example, due to pesticides usage, long-term irrigation and application of organic wastes). In addition, it is important to recognize that agricultural, near-natural and wooded sites, etc. are sometimes developed on deposited wastes or suffer severe aerial deposition when close to industrial sites. In such cases, a combination of the methodologies described in ISO 18400-205 and in this document would be appropriate.

An understanding of the surface water, groundwater and soil gas regimes is essential to the assessment of the potential risks to human health and safety and to other potential receptors including, for example, groundwater resources. However, the provision of detailed guidance on the investigation of groundwater, surface water and soil gas falls outside the scope of this document. For more information on groundwater and surface. Guidance on the sampling of soil gas is provided in ISO 18400-204.

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BS ISO 18400-205:2018
Soil quality — Sampling — Guidance on the procedure for investigation of natural, near-natural and cultivated sites

1 Scope

This document provides guidance on the sampling of soils of

— natural and near-natural sites,

— natural arboreal areas including forests and woods,

— areas used for agriculture (arable and pasture sites),

— areas used for horticulture (including domestic gardens, allotments), and

— areas used for special crop-cultivation, orchards, vineyards, commercial plantations and forests, etc.

It is applicable to

— soil investigations and evaluations in the field, and

— collection of samples for chemical, geochemical, physical, and biological characterization of soil and soil materials in the laboratory.

This document sets out appropriate strategies for the design of sampling programmes, field procedures and subsequent treatment of samples for transport and storage prior to sample pretreatment (e.g. drying, milling). It is intended to be used in conjunction with the other parts of the ISO 18400 series. Attention is, in particular, drawn to the requirements concerning collection, handling and storage of soil for assessment of biological functions in ISO 18400-206.

NOTE 1 Groundwater and surface water can be adversely impacted by agricultural and related activities, such as nitrates and pesticides, and by translocation of soil particles. In turn, knowledge about water quality can provide information about possible sources of groundwater contamination or contaminating run-off. Investigation of groundwater and surface water quality is outside of the scope of this document; relevant guidance is given in the ISO 5667 series of standards. ISO 15175 provides guidance on the relationship between soil properties and groundwater quality.

NOTE 2 It could also be appropriate to investigate ambient air, vegetation, potable water supplies and a variety of other media depending on the findings of the preliminary investigation.

Introduction

This document is one of a group of standards providing guidance on site investigation in general, and sampling in particular, for the principal purpose of determining soil quality. It is intended to be used in conjunction with the other parts of the ISO 18400 series. The role/position of the standards within the total investigation programme is shown in Figure 1.

This document describes investigation and sampling procedures for determination of soil quality on natural, near natural and cultivated sites. Its structure is generally similar to that of ISO 18400-203 which provides guidance on the investigation of potentially contaminated sites. In accordance with ISO 18400-104, it recommends that investigations should be undertaken in three phases:

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— preliminary investigation (desk study and site reconnaissance) in accordance with ISO 18400-202;

— exploratory investigation (this document);

— detailed site investigation (this

document). It is recognized that:

— the preliminary investigation needs to be no more detailed than required by the task in hand (objectives of the investigation), but some basic information is always required for reasons of legality, safety of those carrying out site work including site reconnaissance, and protection of the environment;

— the preliminary investigation might show that no intrusive investigation is required;

— an exploratory investigation might suffice in some cases with no requirement for a detailed investigation;

— an exploratory investigation is not always needed in advance of a detailed investigation;

— it might be desirable to carry out each phase of an investigation in stages;

— during any phase of an investigation it might become apparent that the site should be treated as a potentially contaminated site — decisions will then be required whether to proceed as planned, to delay the investigation, and/or carry out an investigation in accordance with ISO 18400-203.

The guidance also calls for the formulation of a conceptual site model as described in ISO 18400-202. This synthesis and interpretation of the available information needs to be no more detailed than required by the task in hand but helps in the design of intrusive phases of investigation. In practice, the investigator will always have a mental image of the site and formal development of the conceptual site model helps to reveal what could be serious flaws in this mental image.

Note: Clauses 4, 5 and 6 provide guidance applicable to sampling on the generality of natural, near-natural cultivated sites. Clause 7 provides additional guidance in re particular purposes (e.g. determination of mobile nitrogen) and soil types (e.g. peat soils).

BS ISO 18400-206:2018
Soil quality — Sampling — Guidance on the collection, handling and storage of soil for the assessment of biological functional and structural endpoints in the laboratory

1 Scope

This document provides recommendations on the collection, handling and storage of soil for subsequent biological testing under aerobic conditions in the laboratory. It applies to the collection, handling and storage for assessing the effects of soil on microorganisms, invertebrates (e. g. survival, reproduction, growth, behavior) and plants (e. g. development, growth). This document is not applicable to the handling of soil where anaerobic conditions need to be maintained throughout.

This document describes how to minimize the effects of differences in temperature, water content, and availability of oxygen on aerobic processes as well as the fractionation of soil particles to facilitate reproducible laboratory determinations[1][2].

This document is mainly applicable to temperate soils. Soils collected from extreme climates (e.g. permafrost, tropical soils) can require special handling.

NOTE This document does not provide guidance on the collection, handling and storage of soil organisms when assessing the structure and function of soil organism communities in the field. Such guidance is provided in ISO 23611-1 to ISO 23611-6.

Introduction

Soils are both complex and heterogeneous because they consist of both living and non-living components occurring in different combinations. Therefore, the condition of the soil, from collection to completion of an experiment, is considered in relation to effects on the soil organism community (i. e. microorganisms, plants and invertebrates). Temperature, water content, availability of oxygen and duration of storage are all known to affect these organisms, and thus the processes they mediate.

Soils can however be used effectively in the laboratory to investigate effects on soil organisms. In this context it is differentiated between microbial communities on the one side and plants and invertebrates on the other side, since the former are sampled as part of a soil sample, while the latter are added to a soil sample (usually only a few selected species which have been identified as test species beforehand). Therefore, this document covers two different issues:

— It provides guidance on the collection, handling and storage of soil for laboratory use where aerobic microbial activity is the main component of the study. It describes how to minimize the effects of differences in temperature, water content and availability of oxygen on aerobic processes to facilitate reproducible laboratory determinations[1] [2].

— It also provides guidance on the collection, handling and storage of soil for laboratory use where the survival, reproduction, behaviour or growth of invertebrates or plants is the main components of the study. It describes how to minimize the effects of differences in temperature, water content as well as the fractionation of soil particles to facilitate reproducible laboratory determinations[1] [2].

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